Understanding Mechanisms and Effectiveness of Community-Led Total Sanitation (CLTS) in Promoting the Use of Safe Sanitation Services

Thesis (cumulative thesis)
presented to the Faculty of Arts and Social Sciences
of the University of Zurich
for the degree of Doctor of Philosophy

by
Miriam Harter

Accepted in the fall semester 2018
on the recommendation of the doctoral committee:
Prof. Dr. Hans-Joachim Mosler (main advisor)
and Prof. Dr. Urte Scholz

Zürich, 2019

Harter, M. (2019). *Understanding mechanisms and effectiveness of Community-Led Total Sanitation (CLTS) in promoting the use of safe sanitation services.* Dissertation. University of Zurich, Department of Psychology.

Abstract

Open defecation is a problem for health at both individual and community levels. Faecal bacteria cause diarrheal diseases, which account for 20% of premature deaths of children under five. Access to safe sanitation services cuts the risk of diarrheal diseases. Community-Let Total Sanitation (CLTS) seeks to eradicate open defecation by motivating individuals to construct latrines. CLTS uses a set of participatory community-based activities designed to create a goal common to all community members of becoming an open defecation free community. Research provides evidence that CLTS is successful in motivating people to construct latrines and stop open defecation. However, results vary and rarely achieve high enough latrine coverages to protect public health. Thus, the goal of this thesis is to gain a deeper understanding of CLTS effectiveness and mechanisms and provide possible suggestions for improving the intervention.

A cluster-randomised controlled trial was implemented in the Northern Region of Ghana, with 3216 households in 134 communities. Three empirical studies investigated the effectiveness of CLTS in evoking latrine construction and stopping open defecation. The first study investigated factors that characterise the implementation of CLTS and their effects on latrine coverage in communities. The second study tested combinations of theory-based interventions based on the risk, attitudes, norms, abilities and self-regulations (RANAS) model with CLTS to identify possible improvements to the intervention. It further explored the underlying psychosocial determinants targeted by CLTS that mediate the intervention's effect and therefore are responsible for the behaviour change. The third study tested the influence of social identity on intervention effects to investigate whether CLTS is more successful in communities in which social identity is higher.

Overall, the results corroborate the effectiveness of CLTS in evoking latrine construction and the eradication of open defecation. The importance of the follow-up process after CLTS and careful provision of incentives emerged as important implementation factors. The effects of CLTS varied between communities and social identity emerged as an explanation. Psychosocial determinants that mediated intervention effects included social norms, confidence in abilities to construct and maintain latrines, ability to plan the construction process, and commitment.

The thesis combines the findings of the three empirical studies into an integrated behaviour change model for CLTS and gives recommendations for future research. Overall, it suggests combining individual behaviour change theories with factors describing community-level processes for more effective community-level behaviour change campaigns, such as CLTS.

Zusammenfassung

Offene Defäkation (im Folgenden abgekürzt mit OD) stellt ein Problem für die Gesundheit sowohl auf individueller als auch Dorfebene dar. Fäkalkeime verursachen Durchfallerkrankungen, die verantwortlich sind für 20% der vorzeitigen Tode bei unter fünfjährigen Kindern. Zugang zu hygienischen sanitären Einrichtungen reduziert das Risiko von Durchfallerkrankungen. Community-Led Total Sanitation (CLTS) verfolgt das Ziel OD zu beseitigen. CLTS verwendet eine Reihe von partizipativen Aktivitäten auf Ebene der Dorfgemeinschaft um ein gemeinsames Ziel zu erreichen, das einer OD-freien Dorfgemeinschaft. Studien belegen die Wirksamkeit von CLTS, Menschen dazu zu motivieren Latrinen zu bauen und OD zu verringern. Die Ergebnisse variieren jedoch und eine vollständige Reduzierung von OD wird selten erreicht. Ziel der vorliegenden Arbeit ist aus diesem Grund die Vertiefung des Verständnisses über die Wirksamkeit und Mechanismen von CLTS, um mögliche Verbesserungsvorschläge bereitzustellen.

Eine randomisierte Studie wurde 3216 Haushalten in Ghanas durchgeführt. Drei empirische Studien untersuchten die Effektivität von CLTS auf den Bau von Latrinen und OD. Die erste untersuchte Komponenten von CLTS, die den Effekt auf Latrinenbau in Dörfern beeinflussen. Die zweite Studie testete Kombinationen von theoriebasierten Kampagnen auf Grundlage des RANAS-Modells (Risiko, Einstellungen, Normen, Fähigkeiten und Selbstregulation) um potentielle Verbesserungen für CLTS zu ermitteln. Ausserdem wurden zugrundeliegenden psychosozialen Faktoren untersucht, auf die CLTS abzielt, und die für die Wirkung der Kampagne auf Verhaltensänderungen verantwortlich sind. Die dritte Studie untersuchte, ob CLTS in Dörfern mit höherer sozialer Identität wirkungsvoller ist.

Die Ergebnisse bestätigen die Wirksamkeit von CLTS in Bezug auf die Anregung zu dem Bau von Latrinen und der Bekämpfung von OD. Die Bedeutung des Follow-up Prozesses nach einer CLTS Kampagne und die sorgfältige Schaffung von Anreizen erwiesen sich als wichtige Faktoren in der Umsetzung. Der Effekt von CTLS unterschied sich zwischen verschiedenen Dorfgemeinschaften, wobei Unterschiede in der sozialen Identität als Erklärung identifiziert wurde. Zu den psychosozialen Faktoren, die für die Effekte der Kampagne verantwortlich waren, zählen soziale Normen, Vertrauen in die Fähigkeit Latrinen zu bauen und zu erhalten, Fähigkeiten den Konstruktionsprozess zu planen und Kommittent.

Diese Forschungsarbeit kombiniert die Ergebnisse der drei empirischen Studien in ein Verhaltensänderungs-Model und gibt Empfehlungen für weiterführende Studien. Insgesamt schlägt das Modell vor, Theorien über Änderungen von individuellem Verhalten mit Faktoren zu kombinieren, die auf der Ebene der Dorfgemeinschaft wirken, um effektivere Kampagnen für Dorfgemeinschaften, wie etwa CLTS, zu entwickeln

Acknowledgements

Above all, I would like to thank my supervisor Prof. Dr. Hans-Joachim Mosler. Thank you for providing me this opportunity to lead such a large research project and the trust and belief you placed in me. This allowed me to take this challenge. I thank you for being such a humorous and sociable person, a teacher of how to lead a balanced and impactful life. I am grateful to Prof. Dr. Urte Scholz for co-examining this dissertation. I am most grateful to Dr. Jenifer Inauen, who brought me to Eawag, was my mentor, provided continuous support, and who is mainly responsible for my scientific achievements. I thank all my colleagues from the Environmental Social Science Department at Eawag, especially my close colleagues from the Environmental and Health Psychology Group for being at my side during field phases and for emotional support. Special thanks to all colleagues and former colleagues who gave their feedback to this thesis and to Dr. Simon Milligan for language-editing it.

I am most grateful to all collaborating partners of my dissertation project in Ghana, especially to Alberto Wilde, Joseph Asante, and Dominic K. Dapaah from Global Communities Ghana for their support and fruitful collaboration throughout the project. I am grateful to all the health workers of Global Communities, who showed the greatest dedication to improving the sanitation situation of their communities. My gratitude also goes to Abdulai Baba Seidu for his irreplaceable support and to Jonathan Nanyim Kumah and Aduah Josiah Ayipaala for their efforts in the implementation process of this project. I thank the district offices of the study areas for their collaboration and support. I thank Joshua Kpan, Cornelius K.A. Pienaah, Lazarus Jambadu, Stephen Kuunibe, John Balankoo Sumbo, Abraham M. Nunbogu, and Albert Dongzaglah for their collaboration in the field surveys. I am very grateful to Sebastian Mosch, Johanna Braig, Sebastian Niessen, Eva Seumer, Seraina Huder, Vica Tomberge, Innocent K. Tumwebaze, Saskia Engel, Nicole Frank, Maximilian Schneider, and Alexander Mewes for their incredible support during field phases. I would like to thank the dedicated data collection teams and all the study participants in the Northern Region of Ghana. I thank the Bill and Melinda Gates foundation for funding this research project.

Last, I thank my family and friends all over the world. Especially those amazing and strong women that inspire me and to whom I am grateful for sharing my life and being the best source of strength and laughter. Thanks to my flatmates, who distracted me from this thesis and helped me to keep my balance. Thank you, Bastian, for your company through all difficulties during the time of this dissertation project, for always leading me back to the mountains and your infinite optimism. Finally, my heartfelt gratitude to my parents who always believed in me and never stopped supporting each step of my life.

Table of contents

Abbreviations

BCT: Behaviour Change Technique

CLTS: Community-Led Total Sanitation

JMP: Joint Monitoring Program of WHO and UNICEF

MRC: Medical Research Council

NGO: Non-Governmental Organisation

OD: Open Defecation

ODF: Open Defecation Free

RANAS: Risk Attitudes Norms Abilities Self-Regulation Model of behaviour change

RCT: Randomised Controlled Trial

SDG: Sustainable Development Goal

UN: United Nations

UNICEF: United Nations International Children's Emergency Fund

WASH: Water, Sanitation, and Hygiene

WHO: World Health Organisation

List of figures

List of tables

1. General introduction

"All people have the right to safe drinking water, sanitation, shelter, and basic services."
Ban Ki-moon, UN Secretary General, 2010.

In 2010, the United Nations (UN) General Assembly declared access to water and sanitation to be a human right and acknowledged that such access constitutes the basis for achieving all human rights (Solon, 2010). Five years later, the UN General Assembly passed 17 Sustainable Development Goals (SDGs) that call civil societies, non-governmental organisations (NGOs), and governments to action. The SDGs include goal No. 6, providing access to safe sanitation services to all global citizens by 2030 (UN General Assembly, 2015). The progress report on the SDGs presented in 2017 by a joint commission of the World Health Organisation (WHO) and the United Nations International Children's Emergency Fund (UNICEF) reports that by 2015, 39% of the global population had access to safe sanitation services (WHO & UNICEF, 2017). However, 2.3 billion people remain without access to even basic sanitation services, and 892 million people still practise open defecation (WHO & UNICEF, 2017).

1.1. Importance of access to safe sanitation services

Different kinds of environmental pollution are a major cause of the premature deaths and disease the global community is facing today (Prüss-Üstün et al., 2016). In 2015, up to 9 million deaths were caused by pollution-related diseases, which accounts for 16% of premature deaths worldwide (Landrigan et al., 2017). After air pollution, that of water bodies is the second leading risk factor, which combines both unsafe water and sanitation. Most deaths related to polluted water occur due to faecal transmitted diarrhoeal diseases (GBD 2015 Risk Factors Collaborators, 2016).

Most of the population that is affected by unsafe sanitation and lacks access to safe drinking water lives in low- and middle-income countries (Figure 1.1). In South-East Asia, 29.5% practice open defecation, and in Sub-Saharan Africa 22.9%; in comparison, no rates for open defecation are reported in Europe or Northern America (JMP, 2015). Consequently, the burden of diarrheal diseases for low- and middle-income countries is 120 to 150 times higher than for high-income countries (Prüss-Üstün & Corvalán, 2006). Closer examination reveals not only differences at the global regional level but also at the national level between rural and urban areas. Rural regions in low- and middle-income countries have less access to basic and improved sanitation services (50.4%) than urban areas (83.1%) (Prüss-Üstün et al., 2016).

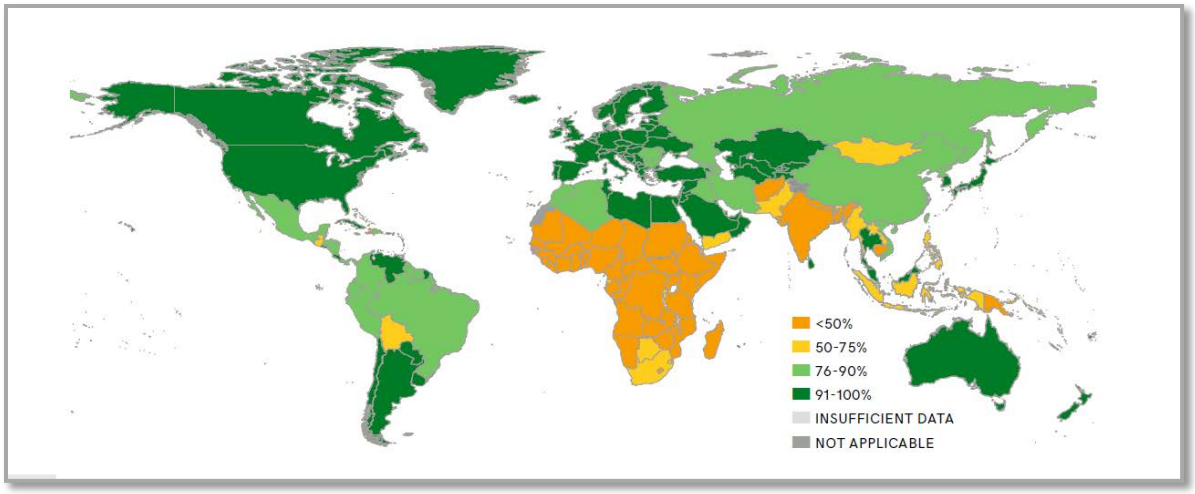


Figure 1.1: *Proportion of population using at least basic sanitation services, 2015.Source: WHO and UNICEF (2017).*

The danger of diarrheal diseases can be cut by providing safe sanitation, as the bacterially contaminated faeces are managed safely and the faecal-oral transmission of pathogens is prevented (see meta-analysis by Wolf et al. (2018) and meta-analysis by Fewtrell et al. (2005)). Accordingly, as many as 5.5% of deaths of children under five in low- and middle-income countries could be prevented by improving access to safe sanitation (Prüss-Ustün et al., 2014). Worldwide, the usage of unsafe sanitation facilities that do not prevent contact of humans with their faeces, decreased by 38.3% from 2005 to 2015, leading to a reduction of diarrhoea-related deaths by 27.8% (GBD 2015 Risk Factors Collaborators, 2016).

The definition of safe sanitation services

The Joint Monitoring Program (JMP) of the WHO and UNICEF was set in place to monitor and report on improvements in providing access to water, sanitation and hygiene (WASH). It therefore also reports on the development of the SDGs. The JMP defined five rungs on a sanitation ladder (Figure 1.2), the last step of which should be reached by all global citizens by 2030 (No. 6 of the SDGs; JMP, 2015). This uppermost step is access to improved sanitation facilities, which hygienically prevent contact of humans with excreta and also provide safe excreta management, such as a pour flush to piped sewer system or ventilated improved pit latrines with later treatment of faecal material in situ or off-site. The second rung down is basic sanitation, which is improved latrines but without the excreta management and not shared with other households (example in Figure 1.3). The third rung down, limited sanitation, is the same but shared with other households. The fourth rung down is unimproved sanitation, which includes the use of simple pit latrines or bucket latrines. The fifth and most basic is open defecation, which means disposing of human excreta in bushes, rivers, forests, and other open spaces (WHO & UNICEF, 2017).

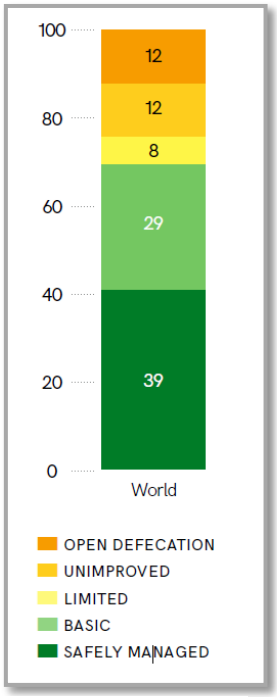


Figure 1.2: *Global Sanitation coverage, 2015. Source: (WHO & UNICEF, 2017)*

Impact of safe sanitation on the risk for diarrheal diseases

As has been stated above, access to safe sanitation services that safely manage human excreta has proven to significantly reduce the risk of diarrheal diseases (World Health Organization (WHO), 2018). This link was formerly considered difficult to prove, but in recent years, scientific evidence has emerged of the impact of safe sanitation on diarrheal diseases (Fewtrell et al., 2005; Prüss-Üstün et al., 2016; Waddington et al., 2009; Wolf et al., 2014). The most recent meta-analysis by Wolf et al. (2018) in collaboration with the WHO reports that interventions promoting latrine use were able to reduce diarrheal risks by 25%.

The question arises whether every step up the sanitation ladder reduces diarrheal risks. Findings are ambiguous: the above-mentioned meta-analysis found no differences in diarrhoea reduction between open defecation and unimproved sanitation services; however, another study found strong reduction effect estimates of 0.60 for basic sanitation systems and 0.84 for improved sanitation compared to unimproved sanitation services (Wolf et al., 2018). Earlier results found an eight percent reduction of diarrhoea even with unimproved sanitation facilities in Mozambique (Elbers et al., 2012), and a cluster-randomised trial in Tanzania reported no significant differences between pathogens in households with improved sanitation facilities and those in households with unimproved facilities (Pickering et al., 2012).

Figure 1.3: *Example for basic sanitation (ventilated pit latrine) in rural Ghana.*

Impact of safe sanitation on health and liveability

As well as reducing the risk of diarrheal diseases, access to safe sanitation leads to other health improvements. Several controlled trials observed latrine use and assessed impact on other health outcomes to evaluate a large government-driven sanitation campaign in India (Hammer & Spears, 2016; Spears, 2012; Spears & Lamba, 2015). They found that this sanitation campaign significantly reduced child mortality and increased children's height by 0.2 standard deviations. Another study showed that children's nutritional condition improved by sanitation campaigns in Orissa, India (Dickinson et al., 2015). Moreover, Vyas et al. (2016) were able to achieve significant reductions in infant stunting by reducing open defecation in Cambodia. A cluster-randomised trial in Mali was equally able to reduce child stunting and also found effects on child heights (Pickering et al., 2015).

Research also provides results that relate to indirect improvements in quality of life through enabling access to safe sanitation services. Spears (2013) related the loss of human capital in India's labour force to the impact of open defecation on premature death and the cost of healthcare facilities. However, benefits of access to safe sanitation go far beyond health impacts. Results from qualitative studies

include increased safety for women, convenience and increased respect, dignity, and prestige (House, 2017; Jenkins & Curtis, 2005).

Community aspect of safe sanitation

Recent research has linked the impact of safe sanitation on health to one important condition: the level of sanitation coverage in the environment. Health risks related to open defecation and unsafe sanitation therefore not only relate to individual behaviour but also depend on the behaviour of the surrounding community (see for example Fuller and Eisenberg (2016)). The meta-analysis presented by Wolf et al. (2018) provided evidence of greater reductions in diarrheal diseases with higher sanitation coverage in communities. Sanitation campaigns only reaching coverages below 75% were able to reduce diarrhoea by an average of 24%, and diarrhoea was reduced by 45% when latrine coverage exceeded 75% (Wolf et al., 2018). Jung et al. (2017b) were able to identify a threshold of 60% coverage in their study communities: lower coverages than 60% were accompanied by a risk for diarrhoea of 82%, and the risk was reduced to 44% for coverages exceeding 60%. Further results regarding the protective influence of higher latrine coverages for individuals come from Geruso and Spears (2018). The authors found that close to three children out of 1000 would be saved for every 10% of neighbours that stop defecating in the open. Vyas et al. (2016) clearly state that "it is the sanitation behaviour of a child's neighbours that matters more for child height rather than the household's sanitation behaviour by itself". The authors found significant height increases for children whose environment changed from 100% open defecation to an environment that is open defecation free (ODF). Finally, the authors of a systematic review and meta-analysis conclude that "neighbourhood sanitation conditions are associated with similar magnitude of reduction in diarrhoea morbidity as household sanitation" (Jung et al., 2017b). The authors strongly recommend sanitation interventions that not only target individual sanitation decisions, but also consider the community focus (Jung et al., 2017a). The following section describes a sanitation campaign that follows this advice.

1.2. Community-Led Total Sanitation (CLTS) for sanitation improvements

Today, Community-Led Total Sanitation (CLTS) is the most widely implemented sanitation campaign worldwide. It seeks to eradicate open defecation and consequently improve the hygiene situation, especially in vulnerable rural areas in low- and middle-income countries. In 1999, the Indian consultant Dr. Kamal Kar and Robert Chambers developed CLTS by considering prior sanitation campaigns that had aimed at eliminating open defecation (Kar & Chambers, 2008). CLTS, as the "community" in its name suggests, is a participatory approach that seeks to shape a new movement of developmental aid with the partnership, empowerment, and ownership of community inhabitants (Chambers, 2013). Chambers, the co-founder of CLTS, intended to change the role of implementing organisations from "commanders" to "supporters" and the local people from "compliers" to self-mobilized "initiates" (Chambers, 2006). In distinction to most prior sanitation approaches, the founders promoted an intervention without subsidies and with the participatory involvement of community members (Kar,

2012). The following sections describe the effects of CLTS. Criticisms of CLTS and a detailed description of the implementation process follow, and this section closes with this thesis's research questions.

The core-concept of CLTS

The main principles of CLTS are described in the Handbook presented by Kar and Chambers (2008):

a. The total elimination of open defecation at community level to achieve open defecation free (ODF) status
b. Creation of a common goal of stopping open defecation that all individuals commit to
c. Focus on the engagement of whole communities instead of individual behaviour change
d. The avoidance of subsidies and promotion for the construction of latrines by community members with local materials without promoting specific types of latrines
e. The implementation of different participatory activities that are realized during a community meeting and expected to elicit strong emotions like shame and disgust to trigger a collective behaviour change
f. Implementation by local facilitators instead of top-down approaches and strong involvement of local "natural leaders" emerging during the community meeting to be leaders in the process

1.2.1. Effects of CLTS

Today, a wide range of funders and implementing organisations support the implementation of CLTS worldwide, such as the World Bank and UNICEF. CLTS is the most widespread sanitation campaign in countries of the global south and is integrated into national sanitation strategies for rural sanitation in at least 30 countries (Venkataramanan et al., 2018). Research has provided several results on the effects of CLTS, whose explicit goal is to eradicate open defecation by constructing and using latrines. Latrine ownership does not necessarily guarantee latrine use or reduction of open defecation. In many cases, especially in India, people do not use their own household latrines. For example, Arnold (2009) found an increase of latrine ownership of 33% for CLTS communities in a program conducted in India accompanied by persistent open defecation rates of 40%. This is why additionally to latrine coverage; open defecation rates are usually reported.

A recent systematic literature review presented by Venkataramanan et al. (2018) on CLTS included 200 sources, but has shown that 81% is grey literature. Only 38 journal publications were found to report results on CLTS, with 9 randomised controlled trials (RCTs). Scientific literature is scarce (Venkataramanan et al., 2018), which is surprising considering the wide application of this approach. The journal articles reported four main outcome measures: (1) latrine ownership at household level or corresponding latrine coverage rates at community level, (2) latrine use or corresponding reduction of open defecation, (3) health outcomes, and (4) some few on latrine quality. The section below summarises some of the main findings.

Latrine construction. Out of nine RCTs, eight reported an increase in latrine ownership of CLTS participants compared to control groups (one did not include results on latrine ownership). Figures ranged from 18.3% difference between control and intervention groups in Ghana (Crocker et al., 2016a), 31% in Indonesia (Cameron et al., 2013), 32% in Mali (Pickering et al., 2015), to 33% in Tanzania (Briceño et al., 2015).

Reduction of open defecation: Out of nine articles that presented figures on open defecation reduction, six found it decreasing in CLTS communities. Figures ranged from 19.9% reduction in Ghana (Crocker et al., 2016a), 6% in Indonesia (Cameron et al., 2013), 71% reduction in Mali (Pickering et al., 2015) and 52% in Tanzania (Briceño et al., 2015).

Of course, the reduction of open defecation is expected to lead to a reduced risk of diarrheal diseases. As mentioned above, the link of access to sanitation services and reduction of health risks is difficult to quantify due to a large number of interrelated factors. Similar difficulties arise when linking open defecation reduction to its impact on health outcomes. Few scientific studies have tried to assess this link for CLTS campaigns, and even existing findings are ambiguous.

Health outcomes of CLTS. An RCT in India reports no significant changes in diarrhoea or other health outcomes, such as anaemia, through CLTS (Patil et al., 2014), as does another trial from Tanzania (Briceño et al., 2015). However, other studies report health outcomes that can be related to CLTS interventions: a 30% reduction in diarrhoea and parasitic infections and an increase in height and weight in Indonesia (Cameron et al., 2013), and 6% less risk of stunting in children and an 4% lower likelihood of underweight in Mali (Pickering et al., 2015).

1.2.2. Criticisms of CLTS

Despite its wide diffusion and the outcomes reported above, CLTS has been criticised for several reasons. One is that it elicits strong negative feelings of shame and disgust during community meetings (Galvin, 2015). The provocation of such feelings was criticised as contrary to human rights (Bartram et al., 2012), ethically untenable, and a return to colonial structures (Engel & Susilo, 2014). The use of bylaws and punishments for people who do not comply with the collective goal was also the object of criticism. Such bylaws and punishments include, for example, public shaming of people defecating in the open, fines for those not constructing latrines, and even locking shut the houses of open defecators (Bartram et al., 2012). The long-term effects of such actions on communities' social structure have not yet been scientifically analysed (Venkataramanan et al., 2018). Further, testing the impact of CLTS on different behavioural or health outcomes has been criticised as problematic, because the broad variation of CLTS implementation makes it difficult to understand the mechanisms of its effects. It is likely that CLTS has as many faces as implementing organisations (Sigler et al., 2014). This heterogeneity means that whether effects are related to single activities, the intensity of the triggering event, the personality of the facilitator, the number of follow-up visits during the post-triggering, or other factors related to CLTS implementation is still unknown (for an overview: USAID (2018)).

In summary, CLTS presents a model for sanitation campaigns focusing on communities in low- and middle-income countries and targeting whole communities to reach high latrine coverages that provide health benefits for all inhabitants. It does so by applying community-based, participatory activities that use strong negative feelings to evoke a collective goal to stop open defecation. CLTS facilitators are expected to accompany and support the communities during their process in becoming an ODF community, if possible in alliance with local community leaders. Research on the effects of CLTS provide positive results, which is the reason that CLTS is the most widely implemented sanitation campaign in the world. However, results are ambiguous and vary across programs, communities, and individuals. The variety of outcomes, including the ambiguity between latrine construction and use, makes an evaluation of effects difficult (Venkataramanan et al., 2018). Additionally, mechanisms of this effectiveness and the long-term impacts of CLTS on social community structures are not yet understood (Novotný et al., 2018; USAID, 2018; Venkataramanan et al., 2018).

The overall goal of this thesis is to gain a deeper understanding of CLTS's effectiveness and shed light on the mechanisms that underlie the intervention's success. The following section provides an overview of the components inherent in the intervention in order to derive research questions related to CLTS and its outcomes and processes.

1.2.3. Implementation process of CLTS

The *Handbook on CLTS* recommends structuring implementation in three phases (for a detailed description, see (Kar & Chambers, 2008)):

Pre-triggering: facilitators collect information about the target community. The *Handbook* mentions several challenges that are relevant for planning and implementing a CLTS intervention. Facilitators therefore should collect information on the community's social composition, access to water, and the current sanitation situation, for example.

Triggering event: facilitators implement a range of participatory activities during a community meeting with the goal of eliciting a collective need for behaviour change. Activities might include a *transect walk*, during which community members lead facilitators to the places of open defection; the drawing of an *open defecation map*, on which community members locate their houses, important landmarks of their community, and the places used for open defecation (see Figure 1.4). Other activities include the description and demonstration of *faecal-oral transmission routes* with the goal of informing community members that open defecation means that "they are eating each other's faeces" (page 18); the *calculation of faeces* produced in the

Figure 1.4: *Open defecation mapping in rural Ghana during CLTS triggering event. Source: author.*

community per year, and the *calculation of medical costs* related to diarrheal diseases. Facilitators might identify *"natural leaders"* during the triggering event and involve them for supporting the construction process. A *community action plan* can facilitate the change to an ODF community, and finally, facilitators can suggest the implementation of *by-laws* developed by community members themselves, such as fines for people defecating in the open.

Post-triggering: in the weeks after the triggering event, facilitators visit the community 1-2 times every week directly after the triggering; later, they reduce the visits to once per month until the community is open defecation free (ODF). During these visits, facilitators should provide support and remind the community members of goals they have set themselves. Visits might include encouraging support for vulnerable households within the community and recruiting children as agents of change.

The *Handbook on CLTS* explicitly tells readers that the activities described should serve as guidance and not a strict manual. Consequently, CLTS implementation varies vastly across countries and cultural settings as well as between implementing NGOs (Venkataramanan et al., 2018). For instance, some implementing NGOs omit the transect walk because participants use the chance to leave the event, and other facilitators report that presenting human excreta in the middle of the community is considered to be taboo (Sigler et al., 2014).

1.2.4. Research questions

A first step in understanding CLTS is to investigate the intervention's outcomes. The studies discussed above report ambiguous findings on CLTS's effects. Therefore, this thesis first tries to evaluate CLTS's effectiveness on individuals' behaviour change in a cluster-randomised controlled trial. Therefore, the first research question (RQ 1) is how effective CLTS is in motivating individuals to construct latrines: do more people own latrines in CLTS communities than in control communities without CLTS interventions? However, the results mentioned above imply that latrine construction is not necessarily a reliable predictor of a reduction in open defecation (see for example (Arnold, 2009)). This leads to the next research question (RQ 2), whether CLTS is able to stop open defecation.

1.3. Mapping approaches towards a better understanding of CLTS

CLTS is classified as what the Medical Research Council (MRC) defines as a complex intervention (Craig et al., 2018). In the MRC's guideline on "[d]eveloping and evaluating complex interventions", the authors describe a complex intervention by five dimensions:

1. Number of and interactions between intervention components
2. Number and difficulty of behaviours that are required by those delivering or receiving the intervention
3. Number of groups or organisational levels targeted by the intervention
4. Number and variability of outcomes

5. Degree of flexibility and tailoring permitted in the intervention

CLTS implementation uses a high number of interventional activities that most probably interact. Activities during the triggering event are relevant, and so are follow-up visits after the event. Implementers are expected to use a variety of performative behaviours to deliver the intervention successfully, and the same is true of participants, who are supposed to construct latrines that are durable and hygienic. The third point concerns the organisational levels or groups targeted in the implementation process. Not only are community members targeted to construct latrines, but local artisans and hardware providers might also be involved. Within the communities themselves, several organisational levels need to be informed and involved, such as political, religious, and traditional leaders and organisations. Some CLTS program implementers particularly target women groups and sanitation committees to spread the innovation, train natural leaders beyond the triggering event, and involve local markets for provision of construction materials (Robinson, 2016; USAID, 2018; Venkataramanan et al., 2018). The fourth point concerns the number and variability of outcomes. As has been discussed already, outcome measures for CLTS range from individual health impacts through latrine quality to latrine coverage within communities. Outcome measures may even contradict each other, as in the case of unused latrines. The last criterion listed here is the degree of flexibility and tailoring that is permitted in the intervention. The CLTS Handbook explicitly invites program implementers to adapt their approaches to every target community and cultural conditions and choose corresponding activities from the CLTS canon (Kar & Chambers, 2008). The MRC's guideline states that adaptation to local conditions might be more appropriate and yield higher effects, but such adaptation makes the evaluation of intervention effects more complex.

Despite the wide application of CLTS, scientific evaluation of it remains scarce: most of the literature describing results and mechanisms is grey literature, as observed by the literature review by Venkataramanan et al. (2018). As has been described above (see page 5 in Section 1.2.1), the effectiveness of CLTS on different behavioural outcomes has been repeatedly reported in literature. However, detailed understanding of CLTS's mechanisms requires further research. This is not surprising given the complexity of CLTS. To achieve a better understanding and consequent improvement of complex interventions, the MRC's guideline provides several approaches. The goal of this thesis is to gain a deeper understanding of CLTS effectiveness and modes of operation. Accordingly, the following chapters of this thesis follow the recommendations of the MRC guideline. Three broad approaches are described to the evaluation of complex interventions.

a) Assessing effectiveness. An intervention should yield a positive impact before underlying processes are investigated to improve effectiveness. This study's research questions 1 and 2 therefore address the effectiveness of CLTS on two different outcome measures: latrine construction and stopping open defecation.

b) Understanding processes. The MRC, citing Oakley et al. (2006) specifies the investigation of processes through three approaches:

- *What was the relation between trial outcomes and variation in the extent and quality of the implementation of the intervention?* This question addresses how an intervention is implemented, the level of adaptation of components, the dose, reach, and fidelity of implementation realisation, and the impact on intervention outcomes (Prestwich et al., 2017). Section 1.4 discusses components of the implementation process of CLTS that emerged in literature and their relationship to intervention outcomes.
- *What processes might mediate the observed relation between intervention and outcomes?* Understanding the processes that are responsible for behaviour change requires investigation of the factors describing such processes (Nielsen et al., 2017). Health behaviour change literature provides theoretical models that describe underlying socio-psychological mechanisms of behaviour change. Section 1.5 presents such a theoretical behaviour change model, which proposes psychosocial factors that might be addressed by CLTS and consequently lead to behaviour change, thus mediating the intervention effect.
- *Did subgroups differ in their responses to the intervention?* To improve intervention outcomes, the MRC recommends improving the understanding of the reasons for positive responses and identifying characteristics that might hinder groups from uptake. Results on CLTS effectiveness show varying responses between individuals and communities (Venkataramanan et al., 2018). Section 1.6 discusses the contextual factors identified in literature that might explain different responses and thus moderate the intervention effect of CLTS.

c) Assessing cost-effectiveness. While first findings indicate that the cost-effectiveness of CLTS is comparable to or higher than other behaviour change campaigns in the sanitation context (Crocker et al., 2017b), a thorough analysis of this aspect is beyond the scope of this thesis.

1.4. Factors enabling the CLTS implementation process

The MRC guidelines on the evaluation of complex interventions recommend investigating intervention processes by considering the extent and quality of the implementation and the relation to outcomes. So far, no detailed process evaluation of CLTS has reported scientific results on the impact of intervention fidelity, adaptations of intervention components, or the dose or reach of CLTS on behavioural outcomes. However, several factors have been shown to enable or hinder CLTS' effectiveness. The following sections draw from three sources to gain an overview of such process factors: the original CLTS Handbook (1.4.1), a literature review on CLTS by Venkataramanan et al. (2018) (1.4.2) and a selection of scientific results on various CLTS implementation factors (1.4.3). The section closes with a synthesis and deduction of research questions (1.4.4).

1.4.1. The CLTS Handbook on implementation factors

The authors of the CLTS Handbook give recommendations on how to implement an intervention successfully and what an environment enabling CLTS implementation should look like, such as support from local governments and favourable physical conditions (e.g., soft soil, access to water) (Kar & Chambers, 2008). For the implementation itself, the CLTS Handbook mentions a large number of potential influencing factors, of which some are described here:

Qualities of the facilitator. The facilitator should use bold language to confront participants with the crude fact that "they are eating each other's shit" and provoke strong negative feelings of shame and disgust (page 35). Facilitators should be persuasive without teaching. Three factors can be derived from these requirements: participants should perceive the facilitator as convincing and like how he or she acts, and strong feelings should be provoked during the triggering event.

Emergence and involvement of natural leaders. During the triggering event, facilitators should identify individuals that are leaders in the discussion or the participatory activities and enrol them in the sanitation improvement process. The CLTS Handbook recommends selecting at least two natural leaders per community.

Intensity of the CLTS process. The Handbook sets a strong focus on the post-triggering process. In follow-up visits, the facilitators should support the community and provide guidance on latrine construction without imposing a particular type of latrine. The number of follow-up visits is not defined, but the Handbook recommends accompanying the community until it is open defecation free, which should not take longer than three months.

The CLTS Handbook does not provide a strict implementation protocol. Instead, it serves as a guideline that invites implementers to adapt the components freely. This fact and the vast spread of CLTS implementation has led to rather diverse literature presented on effective implementation. A recent literature review gives an overview of commonly mentioned success factors.

1.4.2. A literature review on CLTS implementation factors

The literature review by Venkataramanan et al. (2018) is the only overview of factors that are related to positive CLTS outcomes. The factors were derived from grey literature as well as from scientific publications on CLTS. The authors cluster the factors derived from 200 documents reporting on CLTS into seven groups. Five of the seven groups involve contextual conditions that enable or hinder successful implementation, such as the political environment, e.g. national sanitation policies, the administrative context (e.g. coordination between implementing organisations), and the physical environment of the community (e.g. soil conditions). Only two groups refer to the implementation process and the response of participants to it: community participation and implementation quality.

Community participation. A large number of the documents included in the literature review report a higher participation of community members in CLTS as positive (82 documents of 200 (41%)) and the involvement of village-level natural leaders (50 documents (25%)). However, few of the reported results were tested scientifically; these are discussed in the previous section (1.4.3).

Implementation quality. In total, 80 (40%) of the 200 documents referred to triggering quality and 45 (23%) to facilitator skills. Triggering quality was described as selecting the best CLTS activities that fit the needs of the community, thus adapting the protocol in a flexible manner. In 32 documents (16%), the provision of incentives to communities for ODF status was mentioned as a success factor, despite the fact that the CLTS Handbook is strict about avoiding the provision of subsidies and incentives for latrine construction. Some of the factors mentioned so far were tested scientifically on their effects on successful CLTS implementation, and these are also discussed in Section 1.4.3.

1.4.3. Scientific results on success factors of CLTS implementation

Number of follow-up visits and charisma of the facilitator. A study conducted in Indonesia found a significant higher increase of latrine coverage in communities where the intensity of the implementation was higher. Intensity was measured using an index of charisma of facilitators, the number of facilitators involved in triggering, and the number of follow-up visits ((Cameron & Shah, 2017) reported in USAID (2018)).

Provision of subsidies in combination with CLTS. In India, a cluster-randomised trial found 12% higher increases in latrine construction in target households eligible for governmental subsidies (31% increase) than in households not eligible (19% increase) (Pattanayak et al., 2009).

Involvement of natural leaders. A study conducted in Ghana found superior effects of CLTS in latrine coverage in communities where natural leaders were not only selected during the CLTS process, but also received a specific training. Communities in which leaders received such training showed a 19.9% greater reduction of open defecation than communities with only CLTS implementation did.

Community participation. In Ethiopia, a study showed that households that participated in CLTS triggering events were three times more likely to own a latrine than were households that had not

participated in CLTS (Alemu et al., 2018). A cross-sectional study in Mozambique found similar results of higher probability of latrine ownership for CLTS participants. In addition, the study in Mozambique was able to show that information was passed to non-participants of target communities, so that their probability of owning latrines was nearly as high as for people who participated (Harter et al., 2018).

1.4.4. Research questions

The sections above present a selection of implementation factors that were discussed in the CLTS Handbook, in a literature review, and that have been presented in research. In short, these are the qualities of the implementing facilitator, the involvement of natural leaders, the participation of the community in the triggering event, the provision and expectation of subsidies or incentives, and the role of follow-up visits. To gain a deeper understanding of how those factors yield better CLTS outcomes, an investigation is needed that considers several factors in parallel and tests each of their influences on CLTS' effectiveness. That leads to the third research question of this thesis (RQ 3): What are the contributions of the implementation factors to latrine coverage in communities?

1.5. Investigating mediators: psychosocial mechanisms of CLTS

Section 1.3 presents three approaches that were recommended by the MRC to achieve a better understanding of complex interventions. The second of these approaches involved the investigation of mechanisms that are responsible for an intervention's effect. Such an investigation would thus identify the factors, or mediators, that are targeted by the intervention and lead to behaviour change. The National Institute for Health Research (NIHR) further states that the identification of change mechanisms is necessary to systematically improve health behaviour change interventions. It recommends basing assumptions on theoretical behaviour change models (Nielsen et al., 2017). Section 1.5.1 of this chapter introduces a theoretical model that has already successfully been able to explain behaviour change effects in the field of water sanitation and hygiene (WASH). Health behaviour change models such as that presented in Section 1.5.1 are concerned with theory-driven intervention planning. They seek to identify determinants that steer behaviour and target these determinants specifically by applying behaviour change techniques (BCTs) (Conner & Norman, 2005). To improve CLTS, it would be beneficial to identify which determinants are targeted by CLTS and accordingly derive hypotheses explaining the mechanisms of change. These hypotheses then need to be tested, and CLTS can be simplified by limiting interventions to the activities that are most beneficial for behaviour change. Section 1.5.2 uses behaviour change theory to map CLTS components and derive which determinants theory expects to be changed. Section 1.5.3 then identifies which determinants have not yet been targeted by CLTS components and provides BCTs specifically related to these determinants. CLTS could be improved by complementing traditional CLTS approaches with such theory-driven BCTs. This chapter closes by deriving research questions related to the identification of underlying behavioural determinants and improvement of CLTS (1.5.4).

1.5.1. The RANAS model of behaviour change

The Risks, Attitudes, Norms, Abilities, and Self-regulation (RANAS) model draws on established social-cognitive theories from health and environmental psychology, such as the Theory of Planned Behaviour (Ajzen, 1991), the Health Action Process Approach (Schwarzer et al., 2008), the Health Belief Model (Rosenstock, 1974), and the Protection Motivation Theory (Floyd et al., 2000). It has been developed specifically to identify individuals' attitudes and motivations to behaviours within the WASH contexts of low- and middle-income countries (Mosler, 2012).

The core of the model is a set of psychosocial determinants that are responsible for behavioural outcomes (see Figure 1.6). That means the manifestation of various factors leads to either behaviour change or the continuation of the old behaviour. Behaviour in the RANAS model is described by performance or use (e.g., consistent use of a safe water source), the intention of an individual to show the behaviour, and the level of habitual performance of the behaviour (i.e., automaticity).

The psychosocial determinants, the core of the RANAS model, are grouped into five factor blocks (descriptions derived from Mosler (2012)):

Risk factors describe an individual's knowledge and awareness of health risks. Health knowledge captures the understanding of infection pathways, preventive measures, and symptoms of a certain disease. Perceived severity refers to the individual's appraisal of the impact of contracting a disease. Perceived vulnerability describes the subjective perception of the likelihood of contracting a disease.

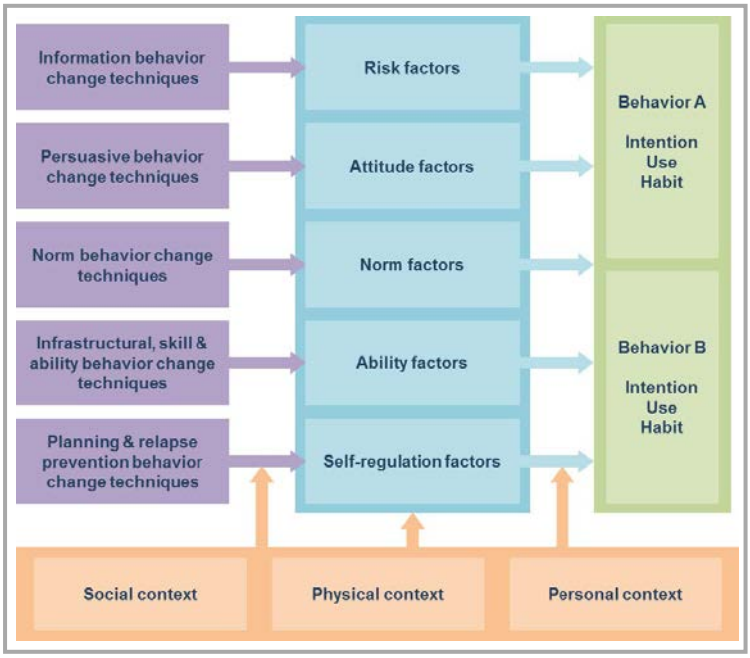


Figure 1.5: *The Risks, Attitudes, Norms, Abilities, and Self-regulations (RANAS) model. Source: Mosler and Contzen (2016)*

Attitude factors are those describing positive or negative views of a behaviour. Instrumental beliefs describe the perception of required efforts (such as costs and time) to show the behaviour and benefits related to the behaviour (e.g., health improvements). Affective beliefs refer to positive and negative feelings related to a behaviour (such as disgust at practicing open defecation).

Norm factors describe the response to the behaviour by the social environment. Descriptive norms refer to the prevalence of the behaviour in either the family or the community context. Injunctive norms describe the perceived approval or disapproval of important others, such as friends, family members,

and religious and community leaders. The personal norm reflects the individual's perception of what he or she should do.

Ability factors represent aptitudes that individuals believe they must have to acquire the behaviour. The ability factors include action knowledge, which refers to the knowledge of how to perform the behaviour, e.g., construct a latrine, and the confidence in being able to perform the behaviour (Self-efficacy). Other factors include confidence in being able to continue the behaviour even if barriers arise (maintenance self-efficacy) and confidence in being able to resume a behaviour once stopped (recovery self-efficacy).

Self-regulation factors are responsible for the performance, continuance, and maintenance of the behaviour, therefore representing abilities an individual must have to perform a behaviour sustainably. Action planning refers to the individual's scheme of how, when, and where to realise the behaviour. Action control is the ongoing monitoring of a behaviour with continuous reference to the target outcome of the behaviour. Coping planning corresponds to the successful handling of barriers that might arise during behaviour performance. The individual might also need to remember the behaviour (for example in the case of handwashing) and needs a degree of commitment to perform it.

Additionally, contextual factors are included in the RANAS model that can influence the depicted mechanisms of an intervention and should therefore considered when planning a behaviour change campaign. The model describes three potential influences of the context on other components: a) contextual factors can influence the intervention–determinants pathway, b) directly influence determinants, or c) moderate the effect of psychosocial determinants on behavioural outcomes. The moderating role of contextual factors on CLTS outcomes is discussed in detail in Section 1.6.

Physical context. Characteristics of the physical environment such as soil conditions and availability of water may affect the pathways of the model components. For example, CLTS promotes the construction of latrines, but whether CLTS evokes changes in people's confidence in being able to construct a latrine might be moderated by the difficulty of digging a pit and therefore depend on soil conditions (pathway a).

Personal context. Income, household size, and age may enable or restrict the effects that are achieved by an intervention via psychosocial determinants on behavioural factors. For example, an individual with higher income might evaluate latrine construction as cheaper than might individuals with lower income (pathway b).

Social context. In their description of the extended RANAS model (Mosler & Contzen, 2016); the authors state that "[t]he social context is constituted by culture and social relations, laws and policies, economic conditions, and the information environment" (page 8). For example, a female CLTS participant might feel strongly committed to using a latrine; however, the taboos of her society forbid her to use the same latrine as male household members (pathway c).

The theoretical model is embedded in a behaviour change approach that guides program implementers towards successful intervention planning (Mosler & Contzen, 2016). The approach suggests a sequence of steps for successful campaign development. After a qualitative survey has identified which behavioural determinants are relevant for the target behaviour in a specific population, these determinants are measured in an analysis that compares "doers" to "non-doers" to identify which determinants steer behaviour change. The next step is to select BCTs from the catalogue presented by the RANAS approach that specifically target these psychosocial determinants (BCTs in the RANAS approach are based on Abraham and Michie (2008) and Michie et al. (2013)). The selected BCTs are integrated to one behaviour change intervention. The last step is to implement and evaluate the intervention in a before–after control trial. This trial gauges the effectiveness of the intervention strategy and allows it to be improved systematically if needed before implementing at scale. The application of this systematic behaviour change approach has been shown to be successful for several WASH-related behaviours: for example, switching to safe water sources in Bangladesh (Inauen & Mosler, 2014), promoting handwashing behaviour in Zimbabwe (Friedrich et al., 2018), Ethiopia and Haiti (Contzen & Mosler, 2015), disinfecting household drinking water in Chad (Lilje & Mosler, 2018), improving latrine cleanliness in Burundi (Sonego & Mosler, 2014), and cleaning water storage containers in Benin (Stocker & Mosler, 2015).

The following section uses the RANAS approach to gain a deeper understanding of the mechanisms of CLTS. The theory-based identification of psychosocial factors that CLTS components target might lead to the deduction of hypotheses on the change-mechanisms of CLTS and finally provide an insight into the factors leading to CLTS' effects.

1.5.2. Identification of psychosocial factors of CLTS

CLTS stands in the tradition of health behaviour change frameworks; however, it does not specify how these are to be applied (USAID, 2018). Despite this lack of a theoretical background, the effects on behaviour change are evident. The goal of this section is to embed CLTS into existing theoretical behaviour change models. A first step is to identify the BCTs involved in CLTS activities. This has been done already by Sigler et al. (2014). The authors compared CLTS programs of 13 different countries and identified the CLTS activities that were most frequently applied by interviewing program implementers. The BCTs used within different CLTS activities were then mapped according to Michie's et al. (2013) behaviour change taxonomy.

This section goes beyond mapping the BCTs of CLTS activities: it aims to identify psychosocial determinants that are theoretically targeted by the mapped BCTs. The picture thus gained will help to inform of the mechanisms-of-change hypotheses for CLTS. Table 1.1 therefore uses the CLTS activities that were extracted by Sigler et al. (2014), but limits the selection to those activities that were mentioned by at least 40% of program implementers. These CLTS activities are presented through original descriptions from the CLTS Handbook (Kar & Chambers, 2008). Similar to Sigler et al. (2014) Table

1.1 indicates the BCTs behind the CLTS activities but instead of applying Michie's et al. (2013) behaviour change taxonomy uses the catalogue presented by the RANAS approach (Mosler & Contzen, 2016). The BCTs thus derived are then referred to the psychosocial determinants theorised by the RANAS approach.

Table 1.1 therefore provides the psychosocial determinants targeted by particular CLTS activities and enables hypotheses to be derived about how CLTS interventions lead to successful behaviour change. It also informs CLTS planners which activities should be combined to target non-doers after identifying which factors are related to the target behaviour of doers.

Table 1.1 shows that CLTS, while not developed from a theoretical framework, targets nearly the complete set of psychosocial determinants of the RANAS model at both triggering event and post-triggering. There is a strong focus on the elicitation of feelings (affective beliefs). As described above, CLTS aims at a "social awakening" by eliciting strong negative feelings, which should lead to immediate action by all community members. Table 1.1 shows that seven of ten CLTS activities depicted here include a BCT that targets feelings. The other focus of CLTS is on the norm factor block: three activities include BCTs that target the personal norm, three that target injunctive norms, and two the descriptive norm. CLTS, as theorised by the RANAS model, therefore achieves behavioural outcomes through changes in the psychosocial determinants, mainly affective beliefs and social norms. The elicitation of strong negative feelings has been discussed critically in the CLTS literature (see Section 1.2.2 and (Bartram et al., 2012; Engel & Susilo, 2014)). Additionally, scientific results that show how negative feelings are necessary for the success of CLTS are still lacking (Bateman & Engel, 2018). The table also indicates that social norms are important for behaviour change in the context of CLTS, what correspondents to the increasing interest on social norms in CLTS literature (Dooley et al., 2016; Novotný et al., 2017; USAID, 2018). Dooley et al. (2016) state that individuals in CLTS communities follow the newly established norm of stopping open defecation because this is what they perceive other community members to be doing (e.g., descriptive norm) and because they want to be accepted and approved by fellow community members (e.g., injunctive norm). Accordingly, scientific studies are emerging that explain CLTS outcomes through the influence of social norms. Injunctive norms were one of several significant predictors for latrine ownership in a cross-sectional study in Ethiopia (Alemu et al., 2018), and both descriptive and injunctive norm were positively related to latrine construction probability in another cross-sectional study on CLTS in Mozambique (Harter et al., 2018).

Despite the wide use in CLTS of psychosocial determinants described by the RANAS model, several determinants are not yet targeted by the CLTS activities depicted in Table 1.1. This situation is addressed in the following section by the selection of BCTs to target those missing determinants.

Table 1.1: *Behaviour change techniques of CLTS based on the RANAS model*

Triggering-event	**Description of the activity** (based on CLTS Handbook)	**BCTs based on the RANAS approach**[1]	**Psychosocial determinant (RANAS)**[1]	**Factor block (RANAS)**[1]
OD mapping	Facilitate the drawing of **a simple map** on the ground showing households, water points and defecation areas to stimulate discussion. Let participants **make faeces visible**, e.g., by using coloured powder. Let them include locations used for defecation in **emergencies**, by children, elderly or disabled inhabitants (p.31).	**BCT 1.** ***Present facts:*** Present information about the circumstances and possibilities of contracting a disease and about the relationship between a behaviour and a disease.	***Health Knowledge***	Risk factors
	Let participants realise that the map is gradually turning coloured (symbol for faeces). Ask them whether the entire village seemed to be **full of shit** (p. 31).	**BCT 8.** ***Describe feelings about performing and about consequences of the behaviour:*** Present […] an unhealthy behaviour as unpleasant and aversive. *In this case: elicit feelings of shame and disgust*	***Affective beliefs***	Attitude factors
Faecal-oral transmission route	Ask people to draw or write the different agents or **pathways, which bring shit into the home.** Then ask how the shit then gets into the mouth. Put a bit of **shit next to bowl of rice**. Flies will come and move between the rice and shit (p. 34).	**BCT 2.** ***Present scenarios:*** Present situations in the everyday life of the participant, showing how a certain behaviour leads to a disease.	***Health Knowledge***	Risk factors
		BCT 3. ***Inform about and assess personal risk:*** Present qualitative and quantitative assessments individually for each person in such a way that the person realises that his/her health is at risk.	***Vulnerability***	Risk factors
	Ask how they feel about **ingesting each other's shit** (p. 36).	**BCT 8.** ***Describe feelings about performing and about consequences of the behaviour:*** Present […] an unhealthy behaviour as unpleasant and aversive. *In this case: elicit feelings of shame and disgust*	***Affective beliefs***	Attitude factors
Glass of water	Take one single **hair and put in shit**, then dip in a glass of water and offer the water to the people. No one will want to drink that water. Ask why they refuse it (p. 34).	**BCT 1.** ***Present facts:*** Present information about the circumstances and possibilities of contracting a disease and about the relationship between a behaviour and a disease.	***Health Knowledge***	Risk factors
		BCT 8. ***Describe feelings about performing and about consequences of the behaviour:*** Present […] an unhealthy behaviour as unpleasant and aversive. *In this case: elicit feelings of shame and disgust*	***Affective beliefs***	Attitude factors

Shit calculations	Calculate **how much human excreta** each individual /a household / the entire community per day / month / year are generating (p. 33).	**BCT 5.** ***Inform about and assess costs and benefits:*** Provide information about costs and benefits of a behaviour (omission) and conduct a cost-benefit analysis.	***Instrumental beliefs***	Attitude factors
	Ask **which household produces most**, and ask everyone to clap and congratulate the family for contributing the most shit to the village (p. 33).	**BCT 8.** ***Describe feelings about performing and about consequences of the behaviour:*** Present […] an unhealthy behaviour as unpleasant and aversive. *In this case: elicit feelings of shame of being displayed in public*	***Affective beliefs***	Attitude factors
Calculating health expenses	Ask people how much they **spend on health treatment**. For diarrhoea, dysentery, cholera and other OD-related diseases, calculated by month or each year (p. 33).	**BCT 5.** ***Inform about and assess costs and benefits:*** Provide information about costs and benefits of a behaviour (omission) and conduct a cost-benefit analysis.	***Instrumental beliefs***	Attitude factors
	Ask if any **poor families** had to **borrow money for emergency treatment** of diarrhoea for any family member. Ask for interest rates (p. 33).	**BCT 8.** ***Describe feelings about performing and about consequences of the behaviour:*** Present […] an unhealthy behaviour as unpleasant and aversive. *In this case: elicit feelings of shame of being displayed in public*	***Affective beliefs***	Attitude factors
		BCT 4. ***Arouse fear:*** Use threatening information that stresses the severity of contracting a disease. *In this case: stress loss of work power and economic resources*	***Severity***	Risk factors
		BCT 12. ***Prompt anticipated regret:*** Bring people to imagine the concerns and regret they would feel after performing undesired behaviours, which are not consistent with their personal norms of living healthily and caring for their children.	***Personal norm***	Norm factors
Natural leaders' selection	**Natural Leaders** (NLs) are activists and enthusiasts who emerge and take the lead during CLTS processes (p.47).	**BCT 14.** ***Prompt identification as role model:*** Ask participants to set a good example (e.g. for children) by engaging in the desired behaviour to influence others' behaviours by one's own behaviour.	***Personal norm***	Norm factors
	Give NLs **recognition** and **encouragement** in every follow-up visit. Honour them through invitations to meetings, and as speakers (p.47).	**BCT 11.** ***Inform about others' approval/disapproval:*** Point out that important others support the desired behaviour or disapprove the unhealthy behaviour. *In this case: the facilitator serves as an important person, who shows his/her approval*	***Injunctive Norms***	Norm factors
Transect walk (Walk of shame)	Walking with community members through the village, asking questions and **visit the sites of open defecation.** […]	**BCT 9.** ***Inform about others' behaviour:*** [Point out that others have already adopted a desired behaviour.]	***Descriptive norm***	Norm factors

		In this case: the open defecation behaviour of all members is made visible		
	People seem to awaken to the problem when **forced by outsiders** to look at and analyse the situation in detail [...also through the] embarrassment experienced.	**BCT 11.** ***Inform about others' approval/disapproval:*** Point out that important others support the desired behaviour or disapprove the unhealthy behaviour. *In this case: the facilitator serves as an important person, who shows his/her approval*	***Injunctive Norms***	Norm factors
		BCT 8. ***Describe feelings about performing and about consequences of the behaviour:*** Present […] an unhealthy behaviour as unpleasant and aversive. *In this case: elicit feelings of shame and disgust by being exposed to strangers*	***Affective beliefs***	Attitude factors
ODF pledge/ commitment	Ask people who are ready to construct latrines to raise hands, and then record their names on a sheet.	**BCT 10.** ***Prompt public commitment:*** Have people commit to a favourable behaviour and make their commitment public, thus showing to others that there are people who perform the behaviour.	***Descriptive norm***	Norm factors
		BCT 36. ***Prompt to agree on a behavioural contract:*** Invite the participant to agree to a behavioural contract to strengthen her/his commitment to a set goal.	***Commitment***	Self-regulation factors
	As they come, give them a big clap, and say that they are **leaders for a clean future**	**BCT 13.** ***Provide a positive group identity:*** Describe people already engaged in the behaviour in an attractive way […]	***Personal norm***	Norm factors
Action plan	Facilitate an action plan with dates for completion.	**BCT 26.** ***Prompt specific planning:*** Stimulate participants not only to formulate what she/he will do, but also when, where, and how she/he intends to achieve her or his goals.	***Action planning***	Self-regulation factors
	Ask how long they will need to stop OD totally. If the answer is more than 2-3 months, ask if 60-90 days of **ingesting each other's shit is acceptable.**	**BCT 11.** ***Inform about others' approval/disapproval:*** Point out that important others support the desired behaviour or disapprove the unhealthy behaviour. *In this case: the facilitator serves as an important person, who shows his/her disapproval*	***Injunctive Norms***	Norm factors

Post-triggering	Description of the activity (based on CLTS Handbook)	BCTs based on the RANAS approach	Psychosocial factors (RANAS)	Factor block (RANAS)
ODF certification	Stress the **recognition** they will receive, and the chance of a special celebration if they become ODF.	**BCT 6.** ***Use subsequent reward:*** [Reward the person each time she/he has performed the desired behaviour or achieved the behavioural outcome.] *In this case: a reward is promised for the achievement of the collective behaviour change.*	***Instrumental beliefs***	Attitude factors
		BCT 8. ***Describe feelings about performing and about consequences of the behaviour:*** Present the performance and the consequences of a healthy behaviour as pleasant and joyful […].	***Affective beliefs***	Attitude factors
Follow-up monitoring	**Support** the members of the community in taking their own action […] encourage **social support**.	**BCT 18.** ***Prompt guided practice:*** Train participants in behaviour enactment by giving instructions, demonstrating the behaviour, letting him/her practice and giving feedback about the correctness of the performance.	***Self-efficacy***	Ability factors
		BCT 21. ***Organise social support:*** Prompt participants to seek practical or emotional support from neighbours, friends, acquaintances, or relatives and/or to initiate social support groups.	***Self-efficacy***	Ability factors
Latrine options	Provide **instructions** on how to become ODF, by explaining latrine types, construction and related costs (p. 37).	**BCT 15.** ***Provide instruction:*** Convey knowhow to improve a person's knowledge about how to perform the behaviour.	***Action knowledge***	Ability factors

[1]Based on the Practical Guide using the RANAS approach by Mosler and Contzen (2016)

1.5.3. Refining CLTS by applying behaviour change theory

Table 1.1 shows that all factor blocks of the RANAS model are targeted, and the first three- risk factors, attitude factors, and norm factors- receive most attention. The other two blocks, ability and self-regulation factors, are targeted, yet five factors are not addressed by any of the CLTS activities. As mentioned above, the ability factors "represent a person's confidence in her or his ability to practice a behaviour" (page 7 in Mosler and Contzen (2016)). This self-confidence has been shown to be a relevant predictor for other health-related behaviours, such as handwashing (Contzen & Mosler, 2015; Seimetz et al., 2016), and latrine cleaning (Sonego & Mosler, 2014). Since latrine construction is an essential element of CLTS, confidence in being able to construct and maintain a latrine may well be important for the success of CLTS. The same is true of the self-regulation factors, which "represent a person's attempts to plan and self-monitor a behaviour and to manage conflicting goals and distracting cues" (page 7 in Mosler and Contzen (2016)). Self-regulation has been shown to be important for behaviour change in handwashing (Contzen & Mosler, 2015; Seimetz et al., 2016) and latrine cleaning (Tumwebaze & Mosler, 2014). Table 1.2 draws on the RANAS approach and presents BCTs that could be included in CLTS campaigns to target those determinants not yet considered by the CLTS activities portrayed in Table 1.1.

Table 1.2: *Suggested BCTs based on psychosocial determinants to improve CLTS*

Factor block (RANAS)	Psychosocial determinant (RANAS)	BCTs based on the RANAS approach[1]	Description of possible activities
Activities proposed for triggering event			
Ability factors	***Maintenance self-efficacy***	**BCT 24. *Reattribute past successes and failures:*** Prompt participants to attribute failures to a temporary lack of skill or adverse circumstances instead of to his/her deficiency and successes as personal achievements.	After the explanation of latrine construction options, include the message that if former latrines had collapsed or have been damaged, this must not happen again. Tell participants that more durable latrine options exist.
Activities proposed for post-triggering			
Ability factors	***Recovery self-efficacy***	**BCT 25. *Prompt coping with relapse:*** Tell participants that lapses are normal when adopting a new behaviour and, though discouraging, not a sign of failure.	In the case of setbacks during the latrine construction process, e.g., because pits collapse, assure community members that this is not their fault and that this can happen. Support them in finding a better site or latrine option.
Self-regulation	***Action control***	**BCT 28. *Provide feedback on performance:*** Give participants a feedback on their behaviour performance.	During the construction process, provide encouraging feedback on the progress. If needed provide guidance on next steps of the construction.

Self-regulation	***Coping planning***	**BCT 30. *Prompt coping with barriers:*** Ask participants to identify barriers to behaviour change and plan solutions to those barriers.	During latrine construction, problems might arise that hinder the further process, for example availability of materials or time. Develop strategies with community members how to overcome such barriers.
Self-regulation	***Remembering***	**BCT 34. *Use memory aids and environmental prompts:*** Prompt the participant to install memory aids or to exploit environmental cues to help to remember the new behaviour and to trigger it in the right situation.	Provide memory aids, such as stickers to those that committed themselves to construct latrines, so that the sticker serves as a reminder of their commitment.

[1]Based on the Practical Guide using the RANAS approach by Mosler and Contzen (2016)

Despite wide coverage of the RANAS factors, it must be noted that behaviour change theories, such as the RANAS model, focus on individual behaviour change and BCTs that are concentrated on psychosocial determinants that explain individual behaviour. In contrast, CLTS focuses at community level and combines BCTs targeting individuals to community-based activities. It thus is unclear, whether individual behaviour change theories fully capture the influence of community-based intervention activities (Dreibelbis et al., 2013; Sigler et al., 2014). The RANAS model partly accounts for the community level by describing affecting pathways of the social context on other model components. The potential influence of social contextual factors is consequently discussed in Section 1.6.

1.5.4. Research questions

The previous sections introduced the RANAS model, a theoretical model that describes psychosocial determinants as potential drivers for behaviour change. The next section used the RANAS model to identify psychosocial determinants, which CLTS activities are theorised to address, and the last section completed the CLTS activities by proposing further BCTs to target psychosocial determinants not yet targeted by CLTS activities. However, the RANAS approach has not yet been applied to CLTS. The fourth research question of this thesis consequently investigates whether CLTS combined with a theory-based intervention is more effective in evoking latrine construction than CLTS alone (RQ 4). Table 1.1 presented the first hypothesis about the psychosocial mechanisms underlying CLTS. Yet, these assumptions have not been tested so far in a before–after control trial. This leads to the fifth research question, which investigates how implemented CLTS activities promote latrine construction by examining which psychosocial mechanisms of the RANAS model explain its effectiveness (RQ 5).

1.6. Investigating moderators: the role of the community for CLTS outcomes

As well as discussing potential mediators of intervention effects, the MRC recommends further investigation of moderators that explain the differing responses of target communities to interventions (Nielsen et al., 2017). The original CLTS Handbook states that "communities respond to CLTS triggering in different ways. Some are inspired to make changes immediately while others are reluctant or undecided at first…" (page 13 in Kar and Chambers (2008)). Indeed, research has presented scientific results that show the effects of CLTS varying between communities and rarely reaching a threshold of at least 60% latrine coverage (for an overview of CLTS effects, see literature review of Venkataramanan et al. (2018) or the study report on CLTS effects in eight African countries of Robinson (2016)). The previous section introduced the RANAS model, which also includes factors that are expected to moderate intervention effects, thus strengthen or weaken effects on intervention outcomes. The next section (1.6.1) describes the classification of moderators within the RANAS model and depicts several moderating factors that have emerged in CLTS literature alongside community factors. Section 1.6.2 concentrates the discussion on the role of the community's social context by introducing the concept of social capital. Social capital has already been investigated as a social contextual moderator and been shown to significantly influence CLTS's intervention effects. Social identity, a similar construct not yet explored in the context of CLTS, is introduced in Section 1.6.3. This section describes theoretically, which influences of social identity are expected. This discussion is followed by the deduction of research questions concerning social identity and its effects on CLTS outcomes (1.6.4).

1.6.1. Moderating factors in CLTS literature

The hypothesis of moderating effects claims that intervention outcomes vary depending on group characteristics (Craig et al., 2018). The investigation of such characteristics helps to understand the variation in intervention effects and adapt the intervention for subgroups in order to gain more successful results (Nielsen et al., 2017). Potential moderating factors are included within the RANAS model (see also section 1.5.1). Those are the three contextual factor blocks: the personal, physical, and social contexts. As described above, the model postulates three pathways the contextual factors can have to influence intervention mechanisms: a) the moderation of the BCTs' effects on psychosocial determinants, b) the direct alteration of psychosocial determinants, and c) the moderation of psychosocial determinants' effects on behavioural outcomes (Mosler & Contzen, 2016). CLTS literature rarely provides results that inform one of the pathways; instead, it tends to show direct influences of moderators on the intervention effects on behavioural outcomes.

Personal context (socio-demographic factors, physical and mental health). In a qualitative assessment of reasons hindering latrine adoption in rural Ethiopia after a CLTS intervention, Alemu et al. (2017) identified households with old-aged or female household heads as less likely to construct latrines. Additionally, they found education to influence latrine uptake, as has been shown in research in other

countries: in a cross-sectional study in Mozambique (Harter et al., 2018), in a cross-sectional study in Ethiopia (Alemu et al., 2018), and in randomised trials in India (Dickinson & Pattanayak, 2009; Shakya et al., 2015). Household size has been shown to have a positive moderating role on intervention effects in India (Dickinson & Pattanayak, 2009) and Ethiopia (Alemu et al., 2018). Results for the influence of income are ambiguous: in a randomised trial in Ethiopia, higher income was related to higher probability of sustaining latrine use in the course of a sanitation intervention (Crocker et al., 2017a), and in Indonesia, the same was found for latrine uptake (Cameron & Shah, 2017). In India as well, a social network analysis study found that households below the poverty line were significantly less likely to construct latrines after participating in CLTS, (Shakya et al., 2015). In contrast, a cluster-randomised trial in India found that income had no explanatory power (Dickinson & Pattanayak, 2009); the same is the case for the study sample in Mozambique, where income was not significantly related to latrine construction (Harter et al., 2018).

Physical context (natural and built environment). In their literature review analysing 200 CLTS-related documents, Venkataramanan et al. (2018) found that 14% described the relevance of soil or groundwater conditions for latrine construction, 12% mentioned access to water in the community, and 17% mentioned climatic conditions. This is in line with results from the cross-sectional study in Mozambique mentioned above, where loose soil and the risk of flooding was related to lower probability of latrine construction and rebuilding after collapse (Harter et al., 2018; Mosler et al., 2018). An additional aspect, investigated in Ethiopia by Alemu et al. (2017), is the availability of space, which had a significant influence on intervention effects on latrine construction.

Social context (culture and social relations, laws and policies, economic conditions, and the information environment). A report evaluating CLTS findings in eight African countries identified an enabling political environment as crucial, thus providing a fruitful ground for CLTS implementation (Robinson, 2016). The author specifies that government engagement and available resources were especially positive for CLTS outcomes. A correlational social network analysis by Shakya et al. (2015) showed that individuals were also more likely to own latrines if members of their social network were also latrine owners. The relationship was even stronger if individuals were from the same caste, had a similar educational background, and had stronger social ties. The mechanisms of influence described here are those postulated by the RANAS model; the influence of the descriptive norm on behavioural outcomes is moderated by social contextual factors (e.g., social ties).

CLTS is a participatory and community-based intervention campaign that conveys its message in the form of community events and strongly focuses on the elicitation of a social norm opposing open defecation. Thus, it focuses clearly on the social context when describing possible difficulties for intervention effects (Kar & Chambers, 2008). As cited above, the Handbook talks about the varying responses of communities to CLTS (page 13) and even classifies responses into “matchbox in a gas

station", thus highly reactive, to a response described as a "damp matchbox" (page 38). It emphasises the community context to explain conditions enabling or hindering CLTS interventions. According to the CLTS Handbook, a community context with high social homogeneity and high social cohesion is enabling, as are communities with a "strong tradition of joint action" (page 15). The next section (1.6.2) introduces the concept of social capital and its influences on CLTS outcomes.

1.6.2. Social capital as a moderator of CLTS' success

Human and physical capital are both concepts describing an individual's possible productivity (Putnam, 1993), and social capital was introduced by analogy to further characterise "the structure of relations between actors and among actors" (Coleman, 1988). Despite the broad use of the term social capital, two dimensions can mainly be differentiated referring back to Coleman's (1988) early definition. One describes the availability of and participation in social networks¸ such as people to turn to when in need of money, and organisational structures within communities, such as women's health clubs and religious groups. The other dimension describes the community's shared norms, social culture of trust, cohesion, and reciprocity (Grootaert & Van Bastelaer, 2002). A community with strong social networks, high levels of trust and cohesion, and a high common understanding of social norms is expected to succeed in "coordination and cooperation for mutual benefit" (Putnam, 1993). The concept of social capital as factors describing the probability of community cooperation has gained attention in the WASH field in low- and middle-income countries, as community-driven approaches rely on community members to collectively install, operate, and maintain systems providing water and sanitation services (Grootaert & Van Bastelaer, 2002; Ostrom, 2000b; Pretty, 2003).

The mechanisms of social capital's influence have been investigated in the collective management of natural resources: for example, dealing with overexploitation of fisheries in a fishing community in Kenya (Bodin & Crona, 2008). The authors of this case study reported high social capital in the form of strong social networks, which allowed members to receive social support and information, and high conflict resolution skills within the community but limited willingness to report on law breaking. They related these findings to the lack of sustainable management of fish extraction. Grootaert and Van Bastelaer (2002) described the positive influence of social capital in a review of literature on community-managed irrigation systems. Factors enabling successful collective management included associations that provided strict regulations and rules on the use and maintenance of irrigation systems that also included a system of sanctions for non-compliers, high homogeneity of irrigation users in social and economic backgrounds, and a high level of mutual trust.

Recently, Dickin et al. (2017) applied the concept of community cooperation to protect common resources to achieving open defecation free communities, as the faecal contamination of water bodies affects every member of the community, whether they practice open defecation or not. In a qualitative study examining the influence of social capital on the uptake of latrines in rural Burkina Faso, the

authors found a sanitation campaign's effectiveness influenced by the level of active involvement in sanitation associations, an indicator of social capital, which provided important sanitation-related information.

In a CLTS study, social capital (i.e., social cohesion and inclusion) was positively related to the probability of owning latrines in intervention communities in Mozambique (Harter et al., 2018). A cluster-randomised and controlled trial in Indonesia investigated CLTS's effects on reducing open defecation and improving child health (Cameron et al., 2015). Communities were more successful in reducing open defecation, if initial participation in sanitation committees, an indicator of social capital, was higher. Communities with higher participation rates were more likely to use social pressure and social sanctions for non-conformers.

1.6.3. Social identity as a moderator of CLTS's success

A similar concept that describes the social structure of communities is social identity. Whereas social capital describes the quality of interactions within a community, social identity focuses on how belonging to a community is personally valued (Kramer, 2006). Social identity was first introduced by Tajfel in 1978, who described the concept as an individual's perception of group membership and the emotional value attached to this membership (Abrams & Hogg, 1990; Tajfel, 1978). Hence, "social identity is a construct that mediates the relationship between the self and the broader social structure of groups and categories" (Terry et al., 1999). This is why the concept of social identity has gained attention in the explanation of group behaviour (Cameron, 2004).

Consequently, social identity has been used in research to explain engagement in collective pro-environmental and health-protective behaviours (Van Zomeren et al., 2008). For example, a study by Bamberg et al. (2015) found social identity to be one successful predictor of the intention to participate in pro-environmental initiatives. Social identity theory assumes that people engage in collective action because a transformation takes place: the individual incorporates group norms into his or her personal norms (Abrams & Hogg, 1990; Deutsch & Gerard, 1955; Hogg & Smith, 2007). The individual conforms to the social norms of both what fellow group members do (a descriptive norm) and what is generally approved (an injunctive norm). Moreover, this transformation is more complete for individuals that strongly identify with their social group. The moderating effect of social identity on the relation of social norms to behavioural outcomes has been shown in previous research. For example, one study on college students' drinking behaviour showed that the relationship of the social group's drinking behaviour (i.e., descriptive norm) and an individual's drinking behaviour was moderated by the strength of social identity with the social group (Neighbors et al., 2010; Rinker & Neighbors, 2014). In one study of pro-environmental behaviour, the intervention effect on the increase of water conservation was moderated by community identification (van Vugt, 2001).

A CLTS intervention aims at eliciting a new social norm that opposes open defecation and tries to motivate entire communities to conform to this newly established social norm. The increasing interest in and actual influence of social norms on CLTS outcomes has been discussed in Section 1.5.2. Including the mechanisms proposed by social identity theory enables further specification of the influence of social norms on CLTS outcomes. Individuals incorporate the newly established norm of stopping open defecation into their own normative system; they perceive it as their personal obligation to construct a latrine, and they do so especially if they identify strongly with their community.

1.6.4. Research questions

This section described factors that have been shown to influence the intervention effect of CLTS on sanitation outcomes. The first set of moderators described the personal and physical contextual factors and their influence on CLTS outcomes. The second part concentrated on one factor of the social context, social capital, and presented studies that showed the moderating role of social capital in the CLTS context. However, the role of social identity in the success of CLTS has not yet been investigated. This leads to the sixth research question (RQ 6): Does social identity moderate the effect of CLTS on open defecation?

2. Aim, objectives and research questions of this thesis

The overall aim of this thesis is twofold: to gain a deeper understanding of CLTS's effectiveness and processes and provide recommendations on possible improvements for CLTS. The Medical Research Council (MRC) has proposed, the approaches to this aim are to assess CLTS's effectiveness on different behavioural outcomes and to understand the processes underlying CLTS interventions (Craig et al., 2018). This aim unfolds in three research objectives: first, to identify factors of the implementation process of CLTS that are most relevant for the intervention's success; second, to investigate the psychosocial mechanisms underlying CLTS's influence on behavioural outcomes and test whether combining CLTS with theory-based interventions is more successful; and third, to test the moderating effect of social identity on the intervention effect of CLTS so as to identify the communities for which it is most and least successful. These three objectives lead to six research questions.

RQ 1: Does CLTS motivate participants to construct latrines?

RQ 2: Does CLTS motivate people to stop open defecation?

As the section summarising CLTS's effects has shown (1.2.2), results are ambiguous and vary between CLTS programs and communities. Section 1.1 outlined how important the percentage of latrine coverage and reduction of open defecation on community level is, as a substantial percentage of the community needs to be open defecation free to provide a protective effect for all community members. Therefore, the first two research questions are concerned with the effectiveness of CLTS on the individual decision to construct a latrine and the effect of CLTS on stopping open defecation.

RQ 3: What are the contributions of different implementation factors to the success of CLTS on community's latrine coverage?

According to the MRC (Craig et al., 2018; Oakley et al., 2006), a better understanding of CLTS's effectiveness involves the investigation of important process factors that are relevant for intervention success. To improve CLTS interventions, the third research question investigates the various contributions of implementation factors to intervention success.

RQ 4: Is CLTS combined with a theory-based intervention more effective in evoking latrine construction than CLTS alone?

RQ 5: Which psychosocial mechanisms of the RANAS model mediate the effect of CLTS on latrine construction?

There is a need to improve CLTS outcomes to achieve full sanitation coverage in communities (Venkataramanan et al., 2018). Moreover, CLTS is not based on behaviour change theories as Sigler et al. (2014), for example, have observed. The RANAS approach to behaviour change, in contrast, provides a detailed guide to assessing the theory-based psychosocial factors underlying a behaviour and select corresponding BCTs that target the factors relevant for effective behaviour change. Based on the RANAS model, Section 1.5 extracted the BCTs underlying CLTS and identified the

psychosocial factors that CLTS most probably targets. Research question 4 is therefore concerned with improving CLTS by combining it with RANAS-based intervention activities. Research question 5 investigates the psychosocial factors underlying CLTS that mediate the intervention effect on latrine construction.

RQ 6: Does social identity moderate the effect of CLTS on open defecation?

Besides understanding potential mediating effects, the MRC recommends including moderators that help to understand, which groups or communities, the intervention helps most effectively (Craig et al., 2018). Several factors moderating the effect of CLTS on sanitation outcomes have been presented in Section 1.6. However, the influence of social identity on CLTS' effects has not yet been investigated. Social identity theory proposes that individuals follow the newly established norm of stopping open defecation because they transform social group norms into their own personal norms; this mechanism is particularly effective if individuals identify strongly with their community (Abrams & Hogg, 1990; Hogg & Reid, 2006). Research question 6 consequently investigates whether CLTS is more successful in stopping open defecation in communities with stronger social identity.

The research questions were investigated through a cluster-randomised and controlled trial in rural Ghana. A first baseline study was conducted in February to April 2016; it assessed psychosocial determinants following the RANAS model of behaviour change and other behavioural and social outcome measures in 3216 households in two districts of the Northern Region in Ghana. Based on the results, RANAS-based interventions were developed to target the psychosocial determinants relevant for behaviour change. The first intervention arm consisted of CLTS, as usually implemented by Global Communities, the partnering NGO in Ghana. Additionally, three intervention arms were implemented combining the usual CLTS implementation of Global Communities with three RANAS-based interventions. The four resulting intervention arms were tested against one control arm. A total of 132 communities were cluster-randomised to the five intervention conditions and intervention effects, and changes in psychosocial determinants were assessed in a first follow-up survey 4-6 months after implementation in February to April 2017. A one-year follow-up was conducted in January to March 2018.

Chapter 3 of this thesis includes findings of the first follow-up survey on the perceptions of CLTS participants on the intervention as well as data from intervention monitoring by Global Communities, and it uses these to answer RQ 3 (What are the contributions of different implementation factors to the success of CLTS on community's latrine coverage?).

Chapter 4 draws on baseline and first follow-up surveys to investigate the effect of CLTS on individual latrine construction (RQ 1: Does CLTS motivate people to construct latrines?). It tests the incremental effects of RANAS-based interventions to answer RQ 4 (Is CLTS combined with a theory-based intervention more effective in evoking latrine construction than CLTS alone?). It also examines

changes from baseline to first follow-up survey in psychosocial determinants achieved by CLTS to answer RQ 5 (Which psychosocial mechanisms of the RANAS model mediate the effect of CLTS on latrine construction?).

Chapter 5 uses data from the baseline survey, which assessed initial social identity in communities prior to CLTS. It investigates the moderation effect of baseline social identity on the effects of the intervention on open defecation rates at one-year follow-up to answer RQ 2 (Does CLTS motivate people to stop open defecation?) and RQ 6 (Does social identity moderate the effect of CLTS on the open defecation rate?).

Chapter 6 summarises empirical findings to answer the research questions and provides an overview of the understanding gained of CLTS's effectiveness and its underlying processes. It presents a model that integrates empirical evidence and suggestions for future research. Recommendations are given to improve CLTS. To complement this thesis, the **annex** contains the questionnaire of the first follow-up survey (AI), descriptive measures supporting Chapter 4 and 5 (AII), further intervention materials (AIII), and photographs from the study project in Ghana (AIV).

3. Implementation factors enhancing the effectiveness of CLTS on latrine coverage in communities of rural Ghana.

Miriam Harter, Jonathan Lilje, Hans-Joachim Mosler

A similar version of this chapter is submitted for publication.

3.1. Abstract

Community-Led Total Sanitation (CLTS) is an approach to improving sanitation to combat open defecation (OD). OD is a health threat to children under five. CLTS promotes the construction of latrines with the goal of declaring communities open defecation free. However, which factors of the implementation process are most important for the success has yet to be ascertained. We implemented a cluster-randomised controlled trial in rural Ghana. The sample comprised 134 communities with an average of 25 households each (*n*=3216). Communities were randomly assigned to either the CLTS intervention or the control arm. Outcome measures were assessed at baseline and 4-6 months later and included process information on intervention implementation and acceptance. The influence of implementation factors on the latrine coverage of communities was assessed using multiple regression analysis. Latrine coverage was significantly related to attendance at the CLTS meeting, the number of supportive community leaders, the expectation of participants of receiving an incentive, and the number of follow-up visits. Implementers of CLTS should direct their attention to the processes following the community meeting. The success of CLTS can be improved by investing in follow-up visits, the support of local leaders, and the careful application of incentives.

3.2. Introduction

In 2015, 2.3 billion people did not have access to safe sanitation facilities and were forced to defecate in the environment surrounding their communities (WHO & UNICEF, 2017). The unsafe disposal of human faeces is one major reason for diarrheal diseases (Mara et al., 2010; Prüss-Ustün et al., 2014), which lead to 1.6-2.5 million deaths per year and account for 19% of all deaths of children under five years in low-or middle income countries (Mara et al., 2010). Children exposed to open defecation tend to be smaller (Spears, 2013) and have lower cognitive skills (Spears & Lamba, 2015).

Community-Led Total Sanitation (CLTS) focuses on latrine construction and usage to eliminate open defecation. This set of community-based and participatory activities has been implemented in communities worldwide by local governmental and nongovernmental institutions (USAID, 2018). The goal of CLTS is to trigger a movement of change towards an improved sanitation situation (Kar & Chambers, 2008). This change is achieved by the commitment of all community members. Only if every single person has access to and uses a household latrine does the community become open defecation free (ODF) and can be judged a hygienically safe environment. CLTS is implemented in three stages: a pre-triggering phase in which information is gathered, the triggering event that uses participatory activities to foster latrine construction, and a post-triggering phase that provides support in a series of follow-up visits.

Overall, CLTS's effectiveness in changing people's behaviour is scientifically and practically proven (Pickering et al., 2015; USAID, 2018; Venkataramanan et al., 2018) and broadly discussed. But its success rates vary widely across projects and countries. The success of CLTS is typically measured by

latrine coverage, the percentage of households within a community that have access to their own latrines. A literature review of sanitation campaigns has reported an average increase in latrine coverage following CLTS of 12% (Garn et al., 2016), and Robinson (2016) presents results of up to 96% latrine coverage in a single case in Malawi. In Ghana, where the majority of the regions have adapted CLTS as their sanitation strategy (USAID, 2018), the effects are surprisingly low. With a national increase in sanitation access in recent years of only 4% (Monney et al., 2015; WHO & UNICEF, 2017), although some specific projects in Ghana have achieved a reduction of open defecation by 19.9% (Crocker et al., 2016a). The wide range in CLTS success rates raises the question how these differences can be explained.

Factors enhancing the effectiveness of CLTS.

A review of CLTS published by USAID in 2018 comments that the "success of CLTS programs is likely to be a function of the implementation modality, as well as both physical environmental and contextual factors. While such factors are cited frequently as crucial, they are not usually well defined." ((USAID, 2018), page 35). The review's authors then divide the characteristics of CLTS implementation processes into two groups: programmatic conditions and community conditions. Programmatic conditions include the implementation, its quality, and its political environment. Community conditions include the physical and social structure of the community and the preconditions for CLTS, such as baseline latrine coverage and social norms. Further indicators for successful implementation can be derived from the *Handbook on CLTS* (Kar & Chambers, 2008), such as inviting as many community members as possible to the triggering event.

Programmatic conditions. The first aspect of programmatic conditions that the review considers is the quality and responsibility of implementation. The authors state, "implementation quality encompasses a number of elements, including the persuasiveness of facilitators of triggering events" and "'intensity'—as defined by frequency of facilitator visits, which can vary greatly from program to program." (Page 27). Another literature review of CLTS research by Venkataramanan and colleagues showed that 23% of the articles reviewed focused on the skills of the facilitators and another 40% included information on the quality of the triggering event itself (Venkataramanan et al., 2018). One case study in India goes so far as to say that the quality of the CLTS outcome depends on the facilitator alone (Kumar & Shukla, 2008). Kamal Kar, the inventor of CLTS, states that while "not everyone can be a good facilitator, the behaviour and attitude of the facilitator is one of the most crucial factors for the success of CLTS (Kar & Chambers, 2008)". That would mean that the more a facilitator convinces and is liked, the more the community is motivated to construct household latrines. The second aspect included in the USAID review is the frequency of follow-up visits by facilitators. Several projects that implemented CLTS stress the need for follow-up visits to sustain the changes achieved by CLTS (Robinson, 2016; Venkataramanan et al., 2018). The *Handbook on CLTS* unambiguously states that

triggering without follow-up visits is “bad practice” (page 43, (Kar & Chambers, 2008)). Most of the literature collected by Venkataramanan et al. refers to follow-up visits as one of the main measures to ensure the quality of CLTS (Venkataramanan et al., 2018). Cameron and Shah found a positive influence on CLTS outcomes with both higher charisma of facilitators and higher frequency of follow-up visits (Cameron & Shah, 2017). Another aspect mentioned is the presence of so-called natural leaders. CLTS focuses strongly on the involvement of such committed community members: they “are activists and enthusiasts who emerge and take the lead during CLTS processes ((Kar & Chambers, 2008), page 5). The *Handbook* recommends selecting 2-4 natural leaders per community (Kar & Chambers, 2008). Crocker et al. (2016a)], studying in rural communities in Ghana, found the success of CLTS being significantly higher when such motivated community members were selected and trained than following the usual CLTS implementation without such specific training.

Community conditions. Besides the initial latrine coverage and the social context in the community, the community conditions described in the USAID review also include subsidies. The review shows that the discussion on subsidies is broad and diverse. The pure CLTS approach works strictly without subsidies, but attempts at combinations have been implemented worldwide with varying effects. The review by Garn and colleagues reports better effects in latrine coverage using subsidy interventions than using CLTS alone (Garn et al., 2016). Pattanayak et al. compared the combination of CLTS and subsidies with CLTS alone and found 2-10% higher increases in latrine coverage in the communities that received CLTS and subsidies (Pattanayak et al., 2009). Venkataramanan et al. report that opinions range from supporting only strict nonsubsidized approaches to the use of targeted subsidies (Venkataramanan et al., 2018).

The CLTS Handbook. Some aspects are not included in either of the groups outlined in the USAID review but are stressed by the *Handbook on CLTS*. These include the use of activities to evoke feelings of shame and disgust. The activities implemented in the community should provide an emotional spur to behaviour change: “Triggering is based on stimulating a collective sense of disgust and shame among community members as they confront the crude facts about mass open defecation and its negative impacts on the entire community” ((Kar & Chambers, 2008), page 21). Pattanayak et al. showed that campaigns that included shaming activities explained two thirds of their intervention effects (Pattanayak et al., 2009). Nevertheless, critics of CLTS observe that evoking such feelings is not in accordance with the protection of human rights and query whether it is even necessary to evoke negative feelings for CLTS to succeed (Bartram et al., 2012; Engel & Susilo, 2014). Whether such feelings as shame and disgust are necessary to driving latrine construction is not yet understood. Another aspect that is strongly stressed by the *Handbook* is participation in CLTS. It seems obvious that without participation nothing will change. However, research on CLTS has not yet provided any scientific results on the relationship between participation rate and latrine coverage. Of the articles included in the literature review by Venkataramanan et al., 82% reported the participation rate being

one of the success factors of CLTS (Venkataramanan et al., 2018). The *Handbook* tells its readers "remember the more people from the community participate the better are the chances of successful triggering" (page 62). The *Handbook* also refers to the time aspect of latrine construction. The process of becoming open defecation free (ODF) takes a community three weeks to three months from the triggering event. However, to our best knowledge the relationship between time since triggering and latrine coverage in the community has not yet been analysed.

Research questions. This study investigates the contributions of the implementation factors described above on latrine coverage in communities. We hypothesize that higher participation in the triggering event, better liking of facilitators, higher conviction and motivation after the triggering event, stronger feelings of shame and disgust, higher number of natural leaders selected, higher number of follow-up visits, greater perception of receiving incentives for latrine construction and longer time since the triggering event are positively related to latrine coverage at community level. The goal of this article is to quantify the individual contributions of these factors towards the success of CLTS as measured by latrine coverage at community level.

3.3. Materials and methods

This study was implemented in rural Ghana jointly by the Swiss Federal Research Institute for Aquatic Science and Technology (Eawag), USAID, and Global Communities Ghana. The project was funded by the Bill and Melinda Gates Foundation. A cluster-randomised controlled trial was implemented with a broad baseline survey in March to April 2016. Community clusters were randomly assigned to four different intervention arms and one control arm. Interventions were developed by Eawag and Global Communities; these were then piloted and implemented in the target area between August and November 2016 by Global Communities. A follow-up survey was conducted four to six months after implementation, in March to April 2017. The Ethics Board of the University Zurich and the Ghana National Health Service approved this research trial.

Procedures. Two districts in Northern Ghana were selected for this cluster-randomised controlled trial, where no CLTS intervention had been realized before: Sawla-Tuna-Kalba district and Bole district. Within these two districts, the local government representatives selected 134 communities according to two selection criteria: accessibility by road and minimum number of 25 households (minimum cluster size). A team of 33 local data collectors was trained in a six-day workshop for both surveys. The main part of the training involved discussion of the structured questionnaire, which included questions on demographics, the sanitation practices of different household members, latrine construction, psycho-social determinants, and the social context of the community. The survey included short observations of the hygienic situation of the household and the latrine, if applicable. The questionnaire for the follow-up survey also included questions on respondents' perceptions of the interventions. All questions were discussed in English and translated into seven local languages: Brefo,

Dagaare, Gonja, Waale, Safalba, Twi, and Mo. Data collectors agreed on keywords in their language for every question. The second part of the training included role-plays, discussions on ethics, and close feedback on interview techniques. The questionnaire was pretested in 66 interviews in two days and adapted to local conditions where appropriate.

In each community, 25 households were selected randomly by the data collectors following the random route method described by Hoffmeyer-Zlotnik (2003). Data collectors were advised to interview every third household in the section of the community they were assigned to. Respondents had to be at least 18 years old and inhabitants of the community for at least 3 months prior to the survey. Adult men and women were considered equally, because the decision for latrine construction was considered to be influenced by both. If no one was at home or the household refused to participate, the data collector tried the next household. Every participant was informed about the purpose of the survey provided written consent for his or her voluntary participation. The face-to-face interview was conducted using electronic devices and lasted 60 minutes on average. Every interview was supervised, and data quality was checked every evening. The same respondents were interviewed again for the follow-up survey.

Sample. The sample size of 3125 households was calculated a priori for a longitudinal cluster-randomised trial with an expected power of 80%, an α-level (two-tailed) of 5%, and an expected medium effect size of 20% between control group and intervention groups on the dichotomous primary outcome variable, latrine ownership. Final sample size exceeds the calculated sample by 91 cases. During the baseline survey, we realized that not all communities contained 25 households, so more communities were included, and again 25 households interviewed wherever possible, resulting in a total sample size of 3216 households (baseline survey). For the follow-up survey, 2704 respondents were interviewed again. The main reasons for dropout were that the respondents had travelled (n=243) or moved out of the community (n=137), and 66 individuals had died. The sample consisted of 42.7% female respondents, participants were on average 44.7 years old (SD=16.32), and 21% were able to read and write. Some 49.2% reported Christianity to be their religion, 26.1% Islam, and 19.2% traditional religions. Most of the households were farmers (80.4%); they had an average monthly income of 202.30 New Ghanaian Cedi (equivalent of 43 USD, SD=380.39 GHS) and an average household size of 8.7 individuals (SD=4.9). The sample used for the study was restricted to 94 communities (1877 households), for which complete data in all hypothesized variables was available at time of data analysis.

Interventions. The protocols for CLTS implementation in the research area were developed following the official *Handbook on CLTS*. Global Communities selected and trained staff for the realization of CLTS, which was implemented in three phases:

Pre-triggering. The community was assessed for its social structure and size, and a date for the triggering event was agreed with community leaders. They were asked to invite female and male community members from all ethnic groups to the triggering event.

Triggering. Facilitators started the session by presenting each other, an opening prayer, and welcoming community members. They facilitated the drawing of a community map on the ground with community institutions such as mosques and water sources. Then, they invited participants to locate both their houses and the spots they used for open defecation. By asking questions about possible paths of the faecal-oral transmission route, the facilitators helped participants recognize the sanitation threat that they faced in their surroundings. If participants seemed hesitant about the sanitation improvement of their community, facilitators were instructed to introduce more activities. These included the presentation of a sealed bottle of water. This was offered to participants to open and taste. A facilitator then took a stick, touched the soil with it, and then dipped it in the water. The water was then presented to participants again. This was to illustrate the contamination of water by small particles, such as those transferred by flies. Facilitators asked participants to agree a date for the community to become open defecation free and set a community action plan in place. The community was exhorted to start digging pits for latrines immediately, and facilitators promised to return the following week. People that emerged as local leaders were identified during the triggering event, their names were noted, and they were later invited to a central training event for natural leaders. At least two natural leaders were identified for every triggered community and trained in the importance of latrine usage and the fecal-oral transmission route. The role of natural leaders in the communities included supporting other community members during latrine construction, spreading knowledge of health hazards, and being role models in the latrine construction process. The triggering event was documented by using the Intervention Monitoring Form (Supporting Information S1).

Post-triggering. Facilitators visited the community every week for 4 weeks, then reduced the frequency of visits to 2 times per month, and later to monthly visits until the community reached the open-defecation-free state. These follow-up visits were used to discuss problems and supervise latrine construction. Global Communities (the local implementing NGO) did not provide any latrines for free but provided construction materials such as cement and vent pipes at wholesale price instead of retail prices. The NGO also encouraged the construction of latrines with locally available materials. Follow-up visits were documented using the Follow-Up Monitoring Form (see Supporting Information S2).

Measures. While some of the variables considered for this analysis come from the two monitoring forms used by the implementing NGO, most data come from information gathered during interviews with respondents in the individual households. This data was first aggregated at community level to match the variables from the monitoring of the triggering sessions. This means that this data represents the average response from all participants within one community as an aggregated measure.

To measure latrine coverage, which is the outcome measure in this analysis, information from individual households within each community was combined using two of the original questionnaire items. Respondents were asked during the interviews whether their household owns a latrine. The data collector verified this information. Households without a latrine were scored with "0", and households that had a latrine at the time of the interview were scored with "1" even if the latrine was still under construction. The final measure thus represents the proportion of households within the community sample having a latrine; this ranges from 0% to 100% coverage (aggregated mean ($M_{agg)}$ = 68.0%; standard deviation (*SD)* = 31.3). This value is considered an approximate measure of latrine coverage across the whole community, because the households interviewed were chosen at random.

Attendance at the triggering event was captured in the interviews when respondents were asked whether they participated in the activity ("1" = yes; "0" = No; M_{agg} = 83.4%; *SD* = 14.3).

Facilitators from Global Communities rated the quality of each meeting on the Intervention Monitoring Form. This uses a four-point scale to represent the level of enthusiasm sensed within the target community in accordance with the terms specified in the *Handbook on CLTS*. However, this item only provides minimal variance with a very high ceiling effect, so we did not consider this measure.

To measure the quality of the meeting, we used data from the individual interviews conducted with the community members of the communities enrolled in the CLTS program. Several questions captured the participant's perception of the meeting and the facilitators. Only respondents who confirmed their presence during the meeting gave answers to these items.

Participants were asked to rate the quality and their perceptions of the meeting and its activities using several items. Participants were asked to rate how much the meeting both convinced and motivated them to build a latrine on a five-point Likert-scale. As the inter-item correlation between these two items was high (α = .74; M_{agg} = 4.64; *SD* = .28), they were combined into a single variable for analysis. To capture the level of shame and disgust evoked by activities during the CLTS meeting, participants were again asked to rate their perception, and items were combined (α = .61; M_{agg} = 2.08; *SD* = .46). Lastly, participants were asked how much they liked the meeting and the facilitators using the same kind of scale. The two items correlated closely and so were combined for analysis (α = .91; M_{agg} = 4.71; *SD* = .31).

Further, the number of follow-up visits of the facilitators to the community was captured during the interviews by asking respondents whether facilitators had come back to their community and how often (M = 2.09; SD = 0.99). This means that this variable does not necessarily capture how many follow-up visits were actually made, but rather how many visits the respondents within a community recalled on average.

In addition, participants were asked whether they were promised anything in return for latrine construction by the facilitators or had understood that there would be incentives ("1" = Yes, "0" = No; M_{agg} = 56.5%; *SD* = 25.5). If participants understood that they would receive something in return for constructing a latrine, they were asked what they had been promised. In 65% (*n*=373) of the cases, they expected a borehole and in 24% (*n*=139), construction materials at reduced prices.

Data that was derived directly from the monitoring forms at community level provided the following information. Time since triggering event was measured using the difference between the recorded date of the meeting and the follow-up survey in March 2017. Time since triggering was measured in months (M_{agg} = 6.16; *SD* = 2.29). The monitoring forms also provided the number of natural leaders (female and male combined) during the triggering session (M_{agg} = 5.5; SD = 2.6). Data was analysed using IBM SPSS Version 22 (Armonk, NY, USA).

3.4. Results

All factors hypothesized as relevant were entered simultaneously into a linear regression model as predictors of the dependent variable, latrine coverage. Full information was available and entered into analysis from 1877 households across 94 communities (M_{agg} = 19.97 households per community; *SD* = 3.06; range 6 - 25). Descriptive statistics, size, and significance of the correlations between all variables with the outcome are displayed in Table 3.1.

Table 3.1: *Descriptive statistics, correlations with outcome*

	Mean	Std. Deviation	N	Correlation with outcome	Sign.
latrine coverage	67.99	31.30	94		
time since triggering	6.16	2.29	94	.054	.303
attendance at meeting	83.36	14.34	94	.47	.000
number of natural leaders	5.46	2.59	94	.13	.106
incentive promised	56.51	25.51	94	.56	.000
convinced and motivated	4.64	.278	94	.39	.000
ashamed and disgusted	2.08	.46	94	.13	.112
liking facilitators	4.71	.31	94	.17	.056
number of follow-up visits	2.09	1.00	94	.60	.000

The model containing all variables was able to explain 51.2% of the variance in the outcome (adjusted R^2) with significant change from the zero model. Standardized coefficients and level of significance of the individuals' predictors are displayed in Table 3.2. The average Variance Inflation Factor (VIF) was 1.51, with all individual VIFs below 2.1. Four variables yielded significant explanatory power. The largest contribution to the power of the regression model came from the incentive promised (β= .38),

followed by the number of follow-up visits to the community (β= .37), then the number of natural leaders (β= .21), and attendance at the meeting (β = .20).

Table 3.2: *Linear regression model of predictors of community latrine coverage*

	Unstandardized Coefficients		Standardized Coefficients		95% Confidence Interval for B	
					Lower	Upper
Variables in the model	B	Std. Error	Beta	Sig.	Bound	Bound
(Constant)	-20.93	53.07		.694	-126.44	84.58
time since triggering	-1.96	1.13	-0.14	.086	-4.21	0.29
attendance at meeting	0.43	0.20	0.20	.035	0.03	0.83
number of natural leaders	2.50	0.90	0.21	.007	0.71	4.28
incentive promised	0.47	0.12	0.38	.000	0.24	0.70
convinced and motivated	5.55	10.80	0.05	.609	-15.93	27.02
ashamed and disgusted	-1.99	5.38	-0.03	.712	-12.70	8.71
liking facilitators	-4.44	8.65	-0.04	.609	-21.63	12.75
number of follow-up visits	11.74	3.27	0.37	.001	5.24	18.25

Note: R^2 = .512; (p < .000). Confidence intervals are 95% bias corrected and accelerated. Confidence intervals and standard errors based on 1000 bootstrap samples.

According to these results, an increase in latrine coverage can be expected if any of these four parameters increases. In other words, while all other predictors remain stable, an increase in coverage of around 0.5% can be expected from every person more out of 100 who attends the meeting or to whom an incentive is promised during the meeting. Further, every single follow-up visit to the community should increase latrine coverage by about 11.5%; every additional natural leader identified should increase latrine coverage by about 2.5%.

3.5. Discussion

To our knowledge, this is the first time that several implementation factors describing the CLTS process have been tested simultaneously for their influence on latrine coverage in communities. This was possible because of the large sample size of communities in this project and because information was collected at both individual and community levels. This allows firm suggestions to be made about improving the CLTS implementation process.

Discussion of factors influencing the success of CLTS. Our results suggest that for CLTS to be maximally successful it is important that as many community members as possible participate at the triggering meeting. Therefore, good preparation of the meeting is important to ensure that all people in the community are aware of the meeting and that it is attractive or even a social norm to attend the

meeting. However, the effect of the number of people who attend the triggering event is not that large, and it might be that the social influence of these attendees on those that did not participate is more important than participation rate alone, as Harter et al. (2018) have shown. Consequently, the effect of the triggering event may be enhanced by prompting attendees to influence community members who did not attend, for example by facilitating further exchange between community members.

According to our results, promoters of CLTS should also try to identify as many natural leaders from a community as possible. Of course, there is a limit to the possible number of natural leaders in each community. However, facilitators could also be trained in motivating natural leaders. One might consider persuasion training with the aim of eliciting the undeclared aspirations and skills of community members. In this project, the implementing NGO, Global Communities, invited natural leaders to attend training together with leaders from other communities. They were trained in the goals of CLTS, the necessity of latrine construction, and the threats of faecal-oral transmission of bacteria. Our study findings indicate that this procedure seems to be promising. The importance of training natural leaders has been shown in a randomised-controlled trial in Ghana (Crocker et al., 2016a), and another study showed that the success of CLTS is mediated by changes in norms, such as the approval of latrine construction by leaders of the community, as natural leaders might be (Harter et al., 2018). The training of natural leaders should be considered more thoroughly. A recent study revealed that the success of CLTS is enabled by focusing on social norms and the belief of participants in their ability to construct and maintain a latrine, fostering the development of detailed action plans towards latrine construction, and leaders publicly showing their approval of latrines (Mosler et al., 2018). Natural leaders could do this.

The number of follow-up visits emerged as a very influential factor. Our results imply that every follow-up visit increases latrine coverage by 11.5%. However, this data was self-reported by respondents in the communities, and perhaps they could not recall or did not witness some follow-up visits. The number might be much higher than reported. The strong influence of follow-up visits on latrine coverage is in line with previous research (Cameron & Shah, 2017) and was also one of the main factors mentioned as influential by 27% of the literature reviewed by Venkataramanan et al. (2018). Further implementation protocols for CLTS should definitely plan consistent follow-up visits. Facilitators should therefore attend to problems faced in the process of latrine construction and serve as consultants for the natural leaders.

Interestingly, we did not find an effect of performance or the acceptance of the facilitator on latrine coverage. In contrast to other factors that were considered in the analysis, the influence of these factors were not significant. Facilitators were trained thoroughly in this project by the implementing organisation and supervised closely during the CLTS process. This might also be a reason why there were no great differences in the perception and performance of facilitators, as their values on the rating

scales were uniformly high. Cameron and Shah (2017) described the positive influence of implementation intensity on CLTS outcome. This intensity was described as the number of facilitators present during the triggering event, the number of follow-up visits, and the charisma of the facilitators. Our data suggests that the latter does not necessarily provide incremental gain to the CLTS outcome.

We also found that the perception of a promise was an important success factor for CLTS in this project. Global Communities drilled boreholes in parallel with the CLTS process, but only for communities that were assessed as especially in need of these. Nonetheless, the condition for the community to receive a borehole was that it was open defecation free. People seem to have understood that an open-defecation-free community receives a new water source in any case. An example statement from one of the respondents illustrates this perception: “They promised if the entire community constructed their own latrines, they would provide the community with water”. Whether this was the case for this specific community was the decision of the implementing NGO. Problems might arise where the community has misunderstood that it will receive a borehole when it will not. It might result in rejection of the importance of latrines and the opposition to the CLTS process (Rains & Turner, 2007). On the other hand, a problem may arise if people construct latrines for another reason than because they think they need them. As long as no false promises are given and the latrines are used, this appears to be a viable strategy. The expectation of incentives for ODF status, their actual provision, and the provision of subsidies in triggered communities were factors reported elsewhere as enhancing CLTS outcomes in the post-triggering phase (Venkataramanan et al., 2018).

We did not find an effect of the emotions elicited through CLTS, and our results indicate that the intensity of shame and disgust was not very high. One explanation could be that facilitators prefer to avoid strong reactions due to taboos and cultural impropriety. Some very frequent activities of the CLTS canon were not used in this project, such as a transect walk or the rice-and-shit activity. This was due to cultural impropriety. Another explanation is that emotions are ephemeral: they arise intensely in a moment but disappear in a few minutes or hours and are therefore not remembered in a follow-up after some months, as previous reports on CLTS have also described (Tyndale-Biscoe et al., 2013).

We expected that the time since triggering was relevant for latrine coverage, as some communities might need more time than others might. In addition, indeed, we found that the variance between communities is high. Some are strongly motivated and complete their latrines rapidly, while others need weeks and months. This might be the reason why time overall is not a relevant factor. On average, the communities in this project needed more time than anticipated by the *Handbook on CLTS* (Kar & Chambers, 2008); this states that communities should only take 3 months after the triggering event to become open defecation free. Venkataramanan et al. (2018) show that 6% of the studies they reviewed report lack of time for latrine construction as an important individual constraint, but no study has yet

discussed the time needed to become open defecation free at community level. Future research might consider the preconditions of communities for the success of CLTS and the interaction effects of time and follow-up visits. As the number of follow-up visits is clearly a relevant predictor, frequent follow-up visits might not only increase the probability of constructing latrines, but also accelerate the building process.

Strengths and limitations. This study has several key strengths. One is the size of the sample, with 3216 households and 134 communities, out of which 94 communities were considered for this analysis. Data was aggregated at community level with an average of 25 households per community, and households were selected randomly in each community. Implementation of CLTS was realized across a broad range of contextual settings (e.g., community size, community composition, and location), so the results hold strong external validity. CLTS as implemented in this study might be considered scalable both for other regions of Ghana and for other countries in West Africa.

However, our study also has some limitations that need to be considered. Our data is nested, as individuals are clustered in communities, and statistical analysis should control for the variance within and between communities. This was not considered in this analysis. A further limitation is that we did not consider initial community conditions that may influence CLTS success, such as the social context of communities, which has been shown to be relevant to success (Cameron et al., 2015). We also included influencing factors based on practical considerations rather than on theoretical background. Of course, it might be the case that other influencing factors, such as the implementation of by-laws and sanctions (Venkataramanan et al., 2018), influenced the success of CLTS in our study significantly but that these were not considered in this analysis.

Overall, our findings suggest that the triggering event of CLTS is only the starting point. However, whether people experience any strong feelings, whether they are convinced by the event, and whether they like the facilitator and the meeting is not relevant for the long-term latrine coverage of the community. CLTS unfolds its power in the weeks after the triggering event. However, the time elapsed since the triggering event is not an explanation for success. The more community members participate in CLTS, the more the movement spreads. Trained natural leaders have to supervise the process kicked off by the triggering event, and facilitators need to return and provide support. The belief or hope of receiving an incentive such as a borehole seems to be an important driving factor that accelerates the construction process.

3.6. Acknowledgements

This research project was funded by the Bill and Melinda Gates Foundation and formed part of the USAID funded WASH for Health project in Ghana. We are grateful to Global Communities Ghana for

the coordination and implementation of CLTS in the research communities; to the District Authorities in Bole and Sawla-Tuna-Kalba districts for logistic support, to Eawag, especially Dr. Jennifer Inauen, for the scientific advice throughout the project. We thank all out colleagues of Global Communities, our field supervisors, masters students and interns for their valuable contributions. We are further grateful to our data collectors for their effort and our respondents in Bole and Sawla-Tuna-Kalba districts for their participation.

4. How does CLTS promote latrine construction and can it be improved? A cluster-randomised controlled trial in Ghana.

Miriam Harter, Hans-Joachim Mosler, Jennifer Inauen

A similar version of this chapter is submitted for publication.

4.1. Abstract

Rationale. Open defecation is connected to poor health and child mortality, but billions of people still do not have access to safe sanitation facilities. Community-Led Total Sanitation (CLTS) promotes latrine construction to eradicate open defecation. However, the mechanisms by which CLTS works and how they can be improved remain unknown. The present study is the first to investigate the psychosocial determinants of CLTS in a longitudinal design. Furthermore, we tested whether CLTS can be made more effective by theory- and evidence-based interventions using the risks, attitudes, norms, abilities, and self-regulation (RANAS) model.

Methods. A cluster-randomised controlled trial of 3216 households was implemented in rural Ghana. Communities were randomly assigned to classic CLTS, one of three RANAS-based interventions, or to the control arm. Pre-post surveys at 6-month follow-up included standardized interviews assessing psychosocial determinants from the RANAS model. Regression analyses and multilevel mediation models were computed to test intervention effects and mechanisms of CLTS.

Results. Latrine coverage increased pre-post by 67.6% in all intervention arms and by 7.9% in the control arm ($p<0.001$). The combination with RANAS-based interventions showed non-significantly greater effects than CLTS alone. The effects of CLTS on latrine construction were significantly mediated by changes in five determinants: others' behaviour and approval, self-efficacy, action planning and commitment. Changes in vulnerability, severity, and barrier planning were positively connected to latrine construction but not affected by CLTS.

Conclusion. This study corroborates the effectiveness of CLTS in increasing latrine coverage, and additional activities can be improved further. Behaviour change techniques within CLTS that strengthened the relevant factors should be maintained. The study also recommends interventions based on the RANAS approach to improve CLTS. Further research is needed to understand the effects of RANAS-based interventions combined with CLTS at longer follow-up.

4.2. Introduction

The global community has set itself the goal of providing access to safe sanitation facilities for all by 2030 (Goal number 6, Sustainable Development Goals). The updated status report on the Sustainable Development Goals of 2017 acknowledged that this goal will not be reached (WHO & UNICEF, 2017). In 2015, 2.3 billion people lacked access to basic sanitation services, and 892 million people practiced open defecation (WHO & UNICEF, 2017). As a result of open defecation, 1.8 billion people worldwide use drinking water that is contaminated with faecal bacteria (WHO & UNICEF, 2017). Every year, the deaths of approximately 361 000 children under five could be prevented by safe sanitation (Prüss-Ustün et al., 2014). Amongst adults, access to safe sanitation can reduce the risk of diarrheal diseases by up to 44% (Esrey, 1996). However, open defecation is not only an individual health hazard. Individuals might change from open defecation to latrine usage, but as long as their neighbours

continue defecating in the open, latrine users remain threatened by faecal contamination of water bodies and food (Coffey et al., 2017; Julian, 2016; Root, 2001). Therefore, a collective behaviour change is required to achieve an environment free of open defecation.

Community-Led total Sanitation (CLTS) is a participatory approach that evokes collective behaviour change in rural settings. Originally developed in Bangladesh in 2008 (Kar & Chambers, 2008), it has since been adopted globally (USAID, 2018). The approach combines a range of activities that are implemented by local facilitators at community level in three phases (Kar & Chambers, 2008). In the initial phase, pre-triggering, each community is visited, and information is gathered about the population and their readiness for behaviour change. In the second phase, triggering, this information is used to adjust participatory behaviour change techniques (BCTs). These are then applied during a community event such as community mapping or a transect walk along which the community is confronted with faecal contamination. The optimal outcome of this community meeting, also called the triggering event, is an increase in community members' awareness that "they are eating their own faeces" ((Kar & Chambers, 2008), page 35). This should lead to a change in sanitation conditions by constructing latrines (Kar & Chambers, 2008). Third, during the post-triggering phase, facilitators support the community in achieving the status of an "open defecation free (ODF) community", by helping in the construction of latrines. The original CLTS process works without any subsidies (Kar, 2003).

Given the wide adoption of CLTS (Cavill et al., 2015), it is surprising that its effectiveness has rarely been scientifically investigated. The few rigorous scientific studies of CLTS's effectiveness have produced diverse and ambiguous findings (Pickering et al., 2015; USAID, 2018; Venkataramanan et al., 2018). A recent meta-analysis on the impact of sanitation campaigns showed that CLTS typically increases latrine coverage by 6-12% and can reach up to 30% (Garn et al., 2016). Another recent review shows that most of the literature on CLTS is grey literature and that only 7% can be categorized as scientific studies (Venkataramanan et al., 2018). This review concludes that CLTS still lacks a systematic and detailed understanding of the mechanisms of behaviour change; this is quite common in behaviour change research. However, the mechanisms of behaviour change strategies need to be uncovered as, for instance, the National Institutes of Health (NIH) have observed (Nielsen et al., 2017). Like any other behaviour change campaign, CLTS seeks to change people's mindsets. It aims at evoking the realization of the need to construct and use latrines to achieve a healthy, faeces-free environment. However, what is yet unknown is which elements of CLTS convince people to change and what changes in people's mindsets actually prompt them to construct latrines.

One theoretical framework that explains such changes in mindsets in the sector of water sanitation and hygiene (WASH) is the risks, attitudes, norms, abilities, and self-regulation (RANAS) model of behaviour change (Mosler, 2012; Mosler & Contzen, 2016). It combines existing theoretical models

of behaviour change, such as the health action process approach (Schwarzer, 2008) and the theory of planned behaviour (Ajzen, 1991). The core concept of the RANAS model is that behaviour change is driven by various psychosocial determinants that need to be in favour of a new behaviour (Mosler, 2012). These determinants are clustered in five factor blocks[1]: 1) Risk factors include individuals' knowledge of a disease, its perceived severity, and their vulnerability to it; 2) attitude factors include feelings about the new behaviour and the perceived costs and benefits of performing it; 3) norm factors include people's perceptions of others' behaviour and their perceived (dis)approval when an individual shows the new behaviour; 4) the ability factor block includes the knowledge of how to perform the behaviour and confidence in starting a behaviour, continuously performing it, and recovering it after relapse; and 5) the self-regulation factor block contains the individual's action plans for the behaviour, how he or she deals with barriers, self-monitoring (e.g., action control) and remembering the new behaviour, and the commitment to performing the behaviour. These psychosocial factors are used to develop theory- and evidence-based behaviour change interventions. Differences are observed between the psychosocial determinants of people who already show the new behaviour and those who do not yet show it. The determinants that show the greatest differences are those targeted in behaviour change campaigns. The RANAS model offers a catalogue of behaviour change techniques (BCTs) that are linked to corresponding psychosocial determinants. Those techniques can be combined to create complex data-driven and population-tailored interventions. Campaigns planned following the RANAS model have been shown to be successful in changing behaviour and evoking new and sustainable habits in various contexts of the WASH sector (Contzen et al., 2015b; Friedrich et al., 2018; Inauen & Mosler, 2014; Lilje & Mosler, 2018). The combination of such data-driven and population-tailored interventions with the CLTS approach might be even more powerful and efficient in changing behaviour than CLTS alone. Such combinations might provide deeper insights into the mechanisms by which CLTS evokes change and might lead to further improvements.

This study therefore investigates the effectiveness of CLTS and combines CLTS with data-driven and population-tailored interventions following the RANAS approach. We hypothesize that CLTS in any combination motivates people to construct latrines (H1) and that the combination of CLTS plus RANAS-based interventions are more effective in evoking latrine construction than CLTS alone (H2). We test these hypotheses by comparing the effects of four interventions with a control arm undergoing no intervention. In addition, this paper is the first to investigate how CLTS promotes latrine

[1] The names of the psychosocial determinants follow the updated version of the RANAS model in Mosler and Contzen (2016): feelings=affective beliefs, beliefs about costs and benefits=instrumental beliefs, other's behaviour=descriptive norms, other's (dis) approval=injunctive norms, personal importance=personal norm, how-to-do-knowledge=action knowledge, confidence in performance=self-efficacy, confidence in continuation=maintenance self-efficacy, confidence in recovery=recovery self-efficacy, barrier planning=coping planning

construction by examining which psychosocial mechanisms of the RANAS model explain its effectiveness.

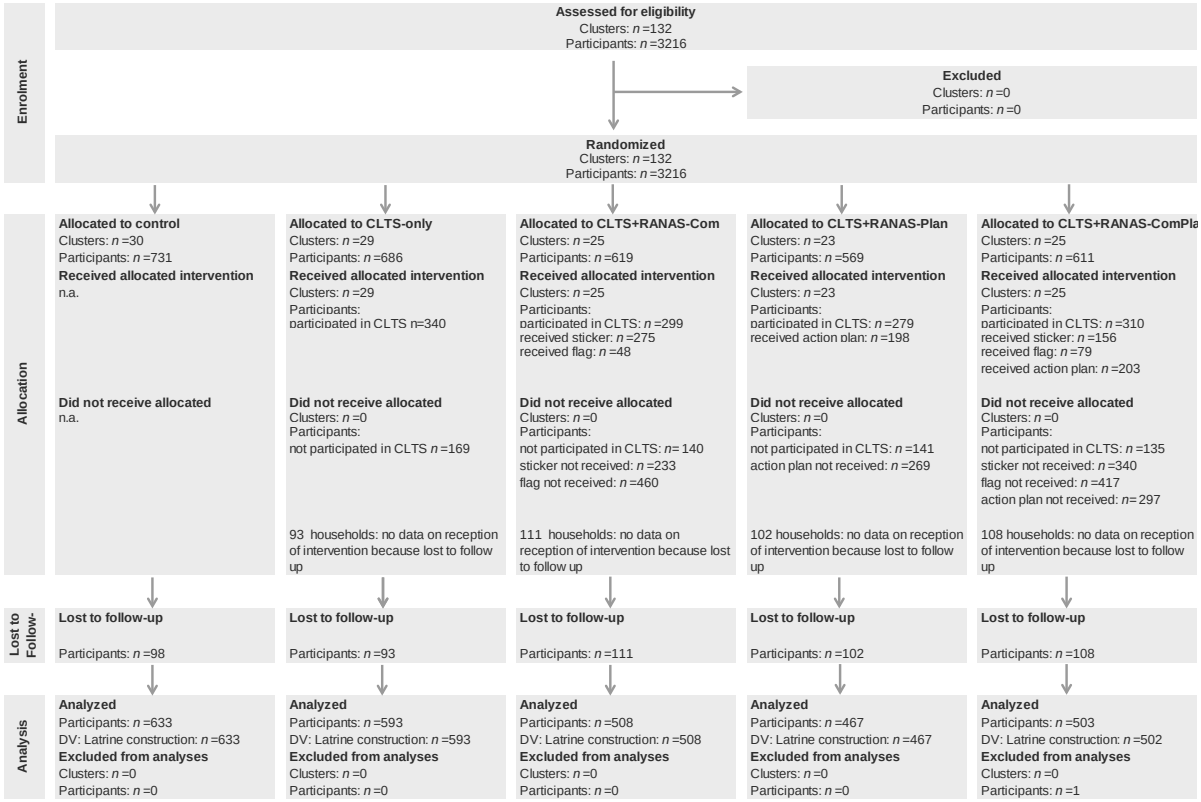
4.3. Methods

Study design. A cluster-randomised, controlled trial was conducted with two panel surveys that measured intervention effects pre-post. The trial comprised four intervention arms and one control arm: classic CLTS (1), CLTS combined with an extended public commitment (2), CLTS combined with a household action planning (3), CLTS combined with public commitment and household action planning (4), and a control arm with no intervention (5). The baseline survey was conducted in February and March 2016, the interventions were implemented between July and November 2016, and a first follow-up survey was conducted in February to March 2017, between 4 and 6 months after the implementation. Long-term effects were measured with a second follow-up survey 14-16 months after implementation, in February to March 2018, but those results are not included in this article's analysis. Participants were allocated randomly to intervention arms on a regionally clustered basis to avoid spillover effects between participants of different interventions. This trial was approved by the Ethical Review Committee of the Ghana Health Service (GHS-ERC: 05/01/2016) and the Ethical Board of the University of Zurich, Switzerland.

Participants. This trial was conducted in two districts of the Northern Region of Ghana, Sawla-Tuna-Kalba and Bole. The two districts were selected by the implementing NGO because CLTS had not been previously implemented in either. Within the two districts, the regional government selected 132 communities based on the following criteria. Communities needed a) to be accessible by car or motorbike from the two district capitals to render the trial practicable and b) to have at least 25 households (the minimum cluster size). Within the communities, household selection followed the random route method (Hoffmeyer-Zlotnik, 2003). Data collectors selected every third household on their way starting from the centre of the community, and each data collector headed in a different direction. Respondents needed to be over 18 years and resident in the community for at least 3 months to be able to answer questions concerning community characteristics. Male and female respondents were considered equally, because the decision to construct latrines might be taken by both. If no one was at home or the person present refused to participate, the next household was selected. Written informed consent was obtained from all participants.

Sample size. We calculated our sample size a priori for a multilevel longitudinal model with repeated measurements and a cluster-randomised controlled trial design for the primary dichotomous outcome variable, latrine ownership (Spybrook et al., 2011). We used Optimal Design Plus Version 3.0 to calculate the sample size. Based on the literature (Clasen et al., 2014), we assumed a medium intervention effect of 20% (Cohen's d=.63) and a drop-out rate of 20%. Assuming power of 80%, a significance level of 5% (two-tailed), and an intra-cluster correlation of ρ=.2, this resulted in a sample

size of 3125 households: 25 clusters for each of the five intervention arms with 25 households per cluster. The actual sample size exceeds the calculated sample size by 91 cases. This resulted from practical decisions during the field survey. We decided to include more communities because during the survey we found that some communities did not include 25 households as expected. To obtain the sample of 3125 households required by our statistical approach, 7 additional communities were included and 25 households interviewed in each if possible. The total and final sample size was therefore 3216 households. Intra-class correlations are displayed in Table 2 in Annex II. The flowchart in Figure 4.1 shows sample development at cluster and individual levels.



Note: DV=Dependent variable. No clusters were lost to follow-up.

Figure 4.1: *Flow diagram of the sample at first follow-up*

Interventions. The RANAS approach was used to develop interventions based on the data gathered about the target population at the baseline survey. The RANAS approach identifies the psychosocial determinants that steer latrine construction and then selects behaviour change techniques (BCTs) that target these determinants (Mosler & Contzen, 2016). Baseline data revealed that latrine construction was steered by determinants of the social and physical context, of the risk factor block, and of attitudes, norms, and self-regulation factor blocks. BCTs were combined in two interventions and added to the classic CLTS intervention. This resulted in five intervention arms: classic CLTS (CLTS-only), three CLTS arms with additional RANAS-based interventions, and a control arm (no intervention). The RANAS-based interventions added to CLTS were an extended public commitment (CLTS+RANAS-Com), household action planning for latrine construction (CLTS+RANAS-Plan) and the combination

of both (CLTS+RANAS-ComPlan). All the intervention protocols were discussed and agreed between the study manager and Global Communities Ghana, the local partnering NGO. Global Communities trained facilitators and coordinated implementation of all the intervention arms with the support of the first author for the RANAS-based interventions. The RANAS-based interventions were first piloted in 12 communities and implemented at scale after final revision of the intervention materials. Intervention protocols can be requested from the first author.

Community-Led Total Sanitation. All three phases of CLTS were implemented according to the CLTS manual (Kar & Chambers, 2008). During the pre-triggering phase, data about the community was collected by the facilitators, such as population size and numbers of existing latrines. Subsequently, all members of the community were invited to a triggering event. The facilitators mainly used three activities for the triggering event. Firstly, an improvised map was drawn on the ground, and community members located their houses on it and then added places they used for open defecation. Secondly, medical costs were calculated for diarrheal diseases and compared to costs for latrines built from local materials. Finally, a community action plan was agreed; this defined a date by which the community wanted to achieve the status of an open defecation free (ODF) community. Individuals that showed leadership qualities were selected as natural leaders and trained by Global Communities to better support latrine construction in their communities. In the post-triggering phase, facilitators visited the community each week to support and train community members and natural leaders on latrine construction and to help solve challenges that community members faced during this process. CLTS formed part of all four intervention arms and public commitment and household action planning were added to this procedure after the triggering event. Intervention protocols showed that overall 67.8% (n=1228) of the respondents participated in the CLTS triggering events.

Public Commitment. Public commitment (CLTS+RANAS-Com) involved participants stepping up in front of the community after the triggering event and showing their commitment to construct latrines. The facilitators were advised to praise the first volunteers as progressive and respected. The remaining community members clapped for those who committed publicly to constructing latrines. The commitment to construct a latrine was made visible by providing stickers to those who had promised to do so. The sticker was to be located where it would be visible to by-passers. After the latrine was constructed, owners received a white flag from the facilitators, which was hung on the latrine. The first follow-up survey showed that of those respondents assigned to this intervention arm, only 42.8% (n=431) received a sticker and 12.6% (n=127) received a flag.

Household Action Planning. The facilitators worked in teams of two and visited every household in the communities allocated to this intervention arm in the week after the triggering event (CLTS+RANAS-Plan). During their visits, a detailed household action plan was developed with the person responsible for latrine construction in each household. The facilitator supported the household

member in choosing a latrine type, estimating the time needed for each step in construction, and considering which materials would be needed and who would be responsible of each step in construction. Both facilitators and household members signed the action plan. It also served as a monitoring tool for both facilitators and household members by which the progress of latrine construction was recorded. The plan was copied for the facilitator and one plan remained with the household. A sample of an action plan can be found in the Annex III (Figure 6). Reports of the intervention implementation showed that of the respondents that were assigned to this intervention, only 41.5% (*n*=401) received a household action plan.

Combination of Public Commitment and Household Action Planning. The two procedures explained above, the public commitment and the household action planning were combined in the fourth intervention arm (CLTS+RANAS-ComPlan). After the triggering event including public commitment, the facilitators returned to the community the following week and completed the household action planning as described above.

Control Group. Communities that were assigned to the control group did not receive any intervention. After completion of the long-term follow-up survey, all control communities received classic CLTS.

Data collection and study measures. For both baseline and follow-up surveys, the research manager conducted one week of training with 33 local data collectors. The training included questionnaire discussion and translation into interview languages (Brefo, Dagaare, Gonja, Waale, Safalba and Twi), roleplays on interview techniques, and discussion of ethics. The training also included two-days pre-testing of the instruments under local conditions. A total of seven teams each with three to five data collectors worked in the two districts, and every team was accompanied by one supervisor (research manager, local field coordinators, interns, and master students). Interviews were structured, conducted face to face, and lasted 50 minutes on average. The following outcome measures were assessed at baseline and follow-up: behaviour (latrine construction, usage and open defection frequencies), information on the social context, and RANAS psychosocial determinants. The surveys also included short observations of the hygiene situation and the household latrine where applicable.

Latrine construction. The question *Does your household have its own latrine?* served as an indicator for a constructed household latrine. Latrine construction was coded with 0=no household latrine and 1= household latrine (completed or still under construction). This self-reported statement was verified by observations of the data collectors (accordance rate 93.6%).

Psychosocial determinants. Psychosocial determinants were assessed using the RANAS approach (Mosler & Contzen, 2016). All items were answered on 5-point Likert scales. We used a visual scale with five black spots of varying sizes to help respondents choose one of the answering options. Every answer option was read out to the respondent and indicated on the visual scale (scale in Annex AIV). Sample items for each factor are displayed in Table 4.1; for a complete picture of all items used for

this analysis, please consult Table A II. 1 in Annex. Where appropriate, single items were combined to scales.

Table 4.1: *Sample items for psychosocial determinants based on the RANAS-model of behaviour change*

Risk factor block	
Vulnerability	Generally, how high do you think is the chance that you get diarrhoea? *1=not at all high to 5=very high*
Severity	Imagine that you have diarrhoea, how severe would be the impact on your life? *1=not at all severe to 5=very severe*
Health knowledge	Could you please tell me for each of the following aspects whether it is a cause of diarrhoea or not? – e.g., Water contaminated by bacteria. *1=Yes; 2=No; 99=I don't know*
Attitudes factor block	
Feelings	How proud are you of your own latrine? *1=not at all proud to 5=very proud*
Beliefs about costs and benefits	How expensive is it to construct your own latrine? *1=not at all expensive to 5=very expensive*
Norm factor block	
Other's behaviour	How many of your relatives within your community constructed an own latrine? *1=(almost) nobody to 5=(almost) all*
Other's approval	How much do people who are important to you (e.g. family, parents, friends) approve that you construct a latrine? *1=approve not at all to 5=approve very much*
Personal importance	Do you feel a personal obligation to construct an own latrine? *1=not at all to 5=very much*
Abilities factor block	
How-to-do-knowledge	Which of the following features are necessary for a hygienic latrine? E.g., vent pipe. *1=Yes; 2=No; 99=I don't know*
Confidence in performance	How confident are you that you can construct a latrine even if this is difficult (e.g. gathering the materials)? *1=not at all confident to 5=very confident*
Confidence in continuation	How confident are you that you can finish the construction of a latrine even if problems arise (e.g. you run out of money)? *1=not at all confident to 5=very confident*
Confidence in recovering	Imagine that the latrine got damaged. How confident are you that you will be able to repair the latrine again? *1=not at all confident to 5=very confident*
Self-Regulation factor block	
Commitment	How committed are you to constructing your own latrine? *1=not at all committed to 5=very committed*
Action Planning	Do you have a plan how you will gather the materials for the latrine construction? *1=Yes;2=No*
Barrier Planning	Do you have a plan how you can construct a latrine if you are running out of materials? *1=Yes;2=No*

Note: The RANAS model also includes Remembering and Action control within the Self-regulation block. Neither psychosocial determinant was found to be appropriate for latrine construction, so neither was assessed.

Data analyses. To test intervention effects on latrine construction, a generalized linear mixed model with a binomial distribution was fitted using IBM SPSS Statistics 22 (Rabe-Hesketh et al., 2004). This model accounted for the nested nature of our data (households within communities) and allowed modelling the heterogeneity between communities. To test whether CLTS was more effective than the control group (H1), a dummy-coded independent variable was entered that was coded 1 for the control arm and 0 for the CLTS arms. Three additional dummy variables tested whether the CLTS+RANAS intervention arms were more effective than CLTS alone (H2). They were coded 1 for the intervention

arm and 0 for the CLTS-only arm. Latrine construction was the outcome variable (0=no own household latrine, 1=own household latrine (finished or under construction)). Random effects were included, using a variance components correlation structure. The syntax for the model calculation can be provided upon request.

To identify which psychosocial determinants of the RANAS model were changed by CLTS and how this change resulted in latrine construction, multilevel mediation analyses were fitted using Mplus Software (Version 8). Mediation analysis tests the causal mechanisms of an intervention on the outcome (here, latrine construction) by partitioning the effect in direct and indirect effects via a mediator, in this case the psychosocial determinants (Hayes, 2013). It investigates whether the intervention effect diminishes when adjusted for a mediating variable. The hierarchical nature of our data prompted us to use a 2-1-1 multilevel structural equation model in which the independent variable, the intervention, varied at level 2 (community), and the mediators (changes in psychosocial determinants) and outcome (latrine construction) varied at level 1 (household) (Preacher et al., 2010). By definition, the effect of the intervention on the mediators occurs at the intermediate level (X-M). Conversely, the effect of the mediators on the outcome (M-Y) can additionally occur at level 1 (households). Hence, the M-Y relationship was allowed to vary across different communities and individuals. Confidence intervals (*CI*) for the indirect effects were calculated using the Monte Carlo Method (Koo & Li, 2016). The CLTS intervention was coded 0=control arm vs. 1=all arms with CLTS. All level 1 determinants were grand-mean centred (Preacher et al., 2010). All pre-post differences in psychosocial factors ranged between -1 and 1, so that positive values reflect increases and negative values decreases in the psychosocial determinants. To test for multicollinearity, we estimated the variance inflation factors (VIF) that were <2 for all determinants, meaning that multicollinearity was not a problem for these data (correlation matrix displayed in Annex Table A II 2). Analysis of intra-class correlations revealed high variance within communities (all values <.5) (Koo & Li, 2016).

4.4. Results

Sample Characteristics. The sample comprised 42% female respondents. The respondents had an average age of 44.6 years (*SD*=14.3), and 20.8% were able to read and write. The average household size was 8.9 members (*SD*=5.5). Some 49.2% reported Christianity as their religion, 22% Islam, and 16.2% traditional religions. Most of the respondents were farmers (80.4%), with an average monthly income of 224 GHS per household (*SD*=1020; equivalent of USD=50). Baseline characteristics of individuals of intervention and control arms are displayed in Table 4.2. The five arms differed in all characteristics except age. Effect sizes for these differences were small (Cohen, 1992). Nevertheless, sensitivity analysis was conducted of the main effects analyses that adjusted for these covariates.

Table 4.2: *Socio-demographic characteristics in intervention and control arms (n=3216)*

Characteristic	Control arm	CLTS-only (*n*=686)	CLTS+ RANAS-Com (*n*=619)	CLTS+ RANAS-Plan (*n*=569)	CLTS+ RANAS-ComPlan (*n*=611)	X^2	*p*	*d*
Occupation						123.8	<.001	.40
Farming	66%	86%	83%	83%	84%			
Other (e.g., mining)	34%	13%	16%	16%	16%			
Religion						102.2	<.001	.36
Islam	39%	25%	18%	20%	22%			
Christian	43%	51%	53%	50%	48%			
Traditional	13%	15%	22%	23%	23%			
Atheist	3%	6%	5%	6%	5%			
Female	49%	42%	37%	37%	44%	28.5	<.001	.12
Literacy	25%	22%	19%	21%	16%	17.1	.002	.12
	M *(SD)*	M *(SD)*	M *(SD)*	M *(SD)*	M *(SD)*	F	*p*	d
Age	44.4 *(16.3)*	43.8 *(15.7)*	45.3 *(15.8)*	43.8 *(15.9)*	45.6 *(17.1)*	1.1	.37	.01
Income	268.5 *(527.3)*	182.7 *(311.1)*	182.2 *(290.3)*	197.3 *(389.7)*	170.3 *(296.3)*	7.6	<.001	.22
Household size	8.4 *(4.6)*	8.6 *(4.6)*	9.2 *(5.1)*	8.9 *(4.9)*	8.5 *(5.0)*	2.8	.020	.08

Note: Effect sizes for independent means according to Cohen (1992): *d*=.2 (small), *d*=.5 (medium), *d*=.8 (large). For sensitivity analysis, all determinants were included.

Intervention effects. To test the effect of the interventions on latrine construction, the CLTS arms were first compared to the control arm, and then the CLTS+RANAS arms were compared to the classic CLTS arm (Table 4.3). In the CLTS arms, an average of 68.2% (*SD*=30.8%) had constructed a latrine at follow-up. Latrine construction in the control arm was significantly lower (*M*=7.9%, *SD*=8.1%). The three CLTS+RANAS intervention arms exhibited a similar proportion of household latrines as CLTS alone (*M*=65.5%, *SD*=31.5%) and did not differ significantly: CLTS + RANAS-Com (*M*=73.2%, *SD*=29.0%, *p*=0.597), CLTS + RANAS-Plan (*M*=67.1%, *SD*=27.8%, *p*=0.964), and CLTS + RANAS-ComPlan (*M*=67.7%, *SD*=33.5%, *p*=0.962). The random effects indicated that the level of community latrine construction varied significantly between communities (*Estimate*= 2.76, *SE*=0.44), *p*=<0.001, *95% CI* 2.02-3.77). A picture of this variance is displayed in Figure 4.2. Sensitivity analyses revealed that including the baseline characteristics did not substantively change the findings. Only household size proved to have a relevant but small effect on latrine construction (*OR*=.92 [*95% CI* 0.90-0.95]).

Table 4.3: *Parameter estimates for multilevel model of intervention effects on latrine ownership*

				CI_{95} for OR	
Fixed Effects (intercept, slopes)	B *(SE)*	*p*	*OR*	LL	UL
Intercept [a]	2.54 *(1.26)*	0.044	12.62	1.07	148.71
Effect of control arm compared to CLTS [b]	-3.83 *(0.42)*	<0.001	0.02	<0.01	0.05
CLTS+RANAS-Com [c]	0.27 *(0.52)*	0.597	1.31	0.48	3.60
CLTS+RANAS-Plan [d]	-0.02 *(0.49)*	0.964	0.98	0.38	2.54
CLTS+RANAS-ComPlan [e]	0.03 *(0.55)*	0.962	1.03	0.35	3.00
			CI_{95}		
	Estimate *(SE)*	*p*	LL	UL	
Random intercept [f]	2.76 *(0.44)*	<0.001	2.02	3.77	
Residual variance [g]	1 (.)	.	.	.	

Note: N=2703, *B*= unstandardized regression coefficients. *CI* =Confidence interval. *OR* = Odds ratio. Probability distribution: binomial, link function: logit. All *p*-values are two-tailed. Outcome variable: Latrine construction 0=no latrine, 1=latrine (finished or under construction).

[a] Intercept: Probability for latrine construction at follow-up when CLTS was received.

[b] CLTS: 0=CLTS arms, 1=control arm.

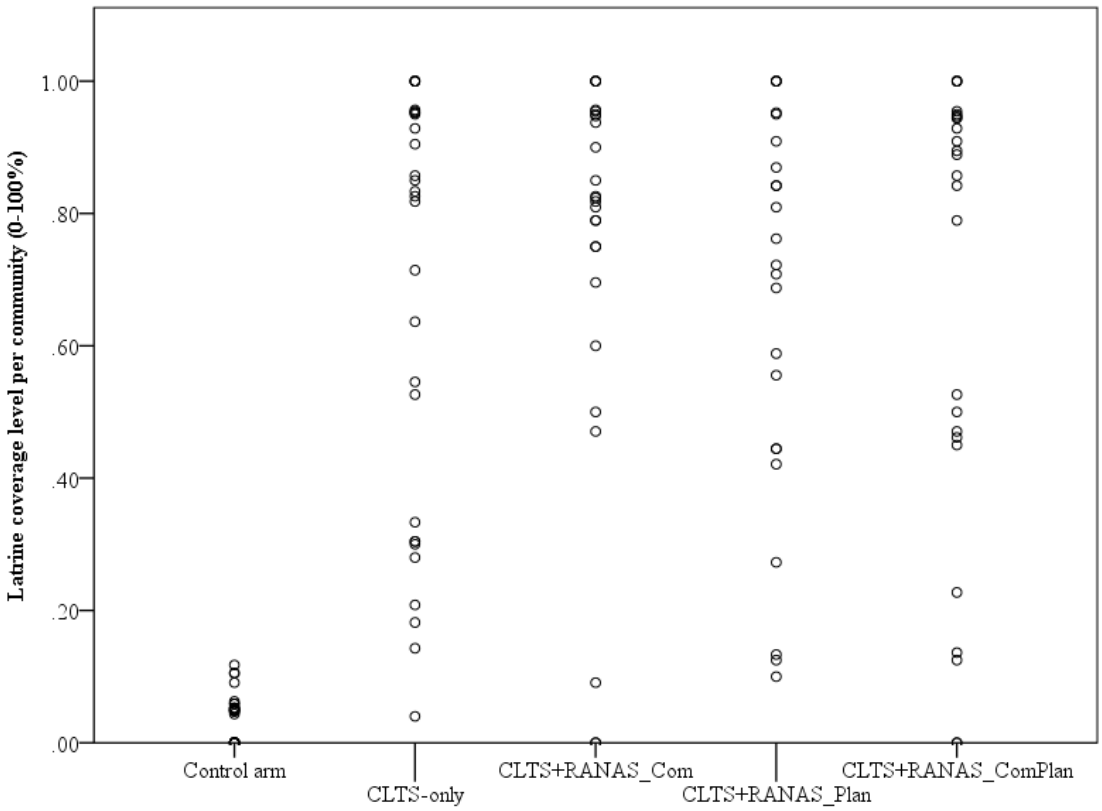
[c] CLTS+RANAS-Com: 0=other arms, 1=CLTS plus RANAS-based public commitment.

[d] CLTS+RANAS-Plan: 0=other arms, 1=CLTS plus RANAS-based household action planning.

[e] CLTS+RANAS-ComPlan: 0=other arms, 1=CLTS plus RANAS-based public commitment + household action planning.

[f] Random intercept: variation in latrine construction between communities.

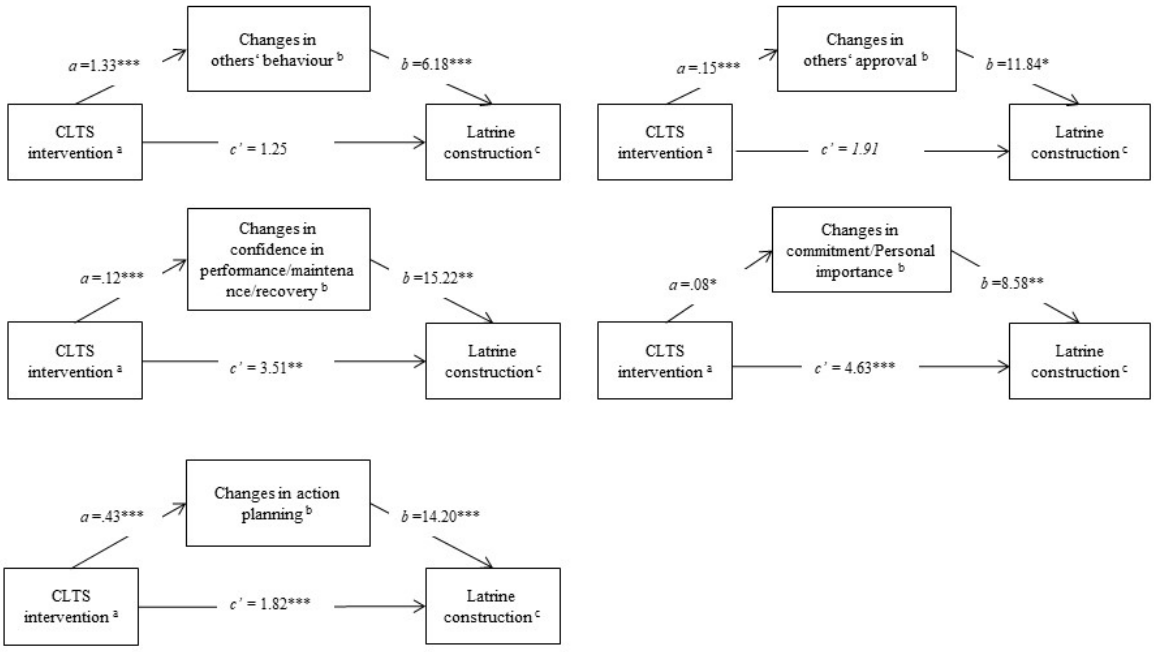
[g] Residual variance: variation in latrine construction between individuals per definition 1 (binomial distribution).



Note= each dot resembles one community

Figure 4.2: *Latrine construction variability per community and intervention arm*

Explaining effects of CLTS on latrine construction through changes in RANAS-based psychosocial determinants. The main effects analysis showed no differences between the CLTS arms in latrine construction. Consequently, the CLTS intervention arms were combined and compared to the control group. Changes in the values for five of the psychosocial determinants of the RANAS model mediated the effects of CLTS on community latrine construction (see Figure 4.3, and Table AII 3 in annex). The intervention significantly increased community-level perceptions that others owned a household latrine (Others' behaviour, *B [SE]*=0.28 *[0.05], p*<.001) and increased the perception that community leaders approved latrine construction (Others' approval, B*[SE]*=.15 *[0.04], p*<.001). The intervention also increased Confidence in constructing, maintaining, and repairing a latrine (*B [SE]*=.12 *[0.02], p*<.001) and strengthened people's commitment to constructing their own household latrines (B*[SE]*=.08 *[0.04], p*=.041). Finally, the intervention promoted the formation of action plans for latrine construction (B*[SE]*=.43 *[0.09], p*<.001). These changes individually increased the probability of communities having higher latrine coverage (Others' behaviour: B*[SE]*=6.18 *[0.45], p*<.001; Others' approval: B*[SE]*=11.84 *[4.76], p*=.013; Confidence in performance/ maintenance/ recovery: B*[SE]*=15.22 *[4.45], p*=.001; Commitment/Personal importance: B*[SE]*=8.58 *[3.12], p*=.006; Action planning: B*[SE]*=14.20 *[0.34], p*<.001). Indirect effects were found to be significant for Others' behaviour (B*[SE]*=1.75 *[0.34], 95% CI*= 1.08-2.42), Confidence in construction/ maintenance/ recovery (B*[SE]*=1.75 *[0.69], 95% CI*= 0.39-3.10), Commitment/Personal importance (B*[SE]*=.67 *[0.42], 95% CI*= -.18-1.52), and Action planning (B*[SE]*=6.03 *[1.31], 95% CI*= 3.47-8.59). Changes in these determinants mediated the effect of CLTS on latrine ownership. The relationship between changes in the psychosocial determinants and the probability of latrine coverage was significantly different within communities for all mediators considered for analysis (estimates for random effects on level 1 are displayed in the Annex Table AII 3). The intervention further had a significant effect on Feelings (*B[SE]*=-0.05 *[0.01], p*<.001), so that CLTS participants experienced a loss in their belief that a latrine would make them more respected by other community members and that owning a latrine would make them feel proud. But this change was not associated with the probability of latrine construction (*B[SE]*=-21.20 *[11.91], p*=.075). The other determinants were not significantly affected by the CLTS intervention. Changes in some of the behavioural determinants were found to be relevant to the probability of constructing a household latrine, but were not significantly addressed by the CLTS intervention. People with higher negative changes in Vulnerability were more likely to construct latrines (B*[SE]*=-6.43 *[1.73], p*< .001). People who had stronger positive changes in their perception of the severity of getting diarrhoea were more likely to construct latrines (B*[SE]*=6.36 *[2.79], p*=.023) as were people with higher increases in their felt abilities to cope with problems arising during latrine construction (B*[SE]*=7.64 *[3.34], p*=.022). The only determinant not influenced by the intervention and not related to latrine construction probability was Beliefs about costs and benefits.



[a] CLTS intervention 0=control arm, 1=all interventions with CLTS
[b] Changes in the mediator (follow up-baseline), range -1 to 1
[c] Latrine construction was coded 0=no latrine, 1=latrine (finished or under construction)
Significance levels: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

Figure 4.3: *Single-mediation models of the intervention effect on latrine construction mediated by changes in RANAS-based psychosocial determinants*

4.5. Discussion

This study investigated the intervention effect of a classic CLTS intervention on latrine construction. It is the first randomised controlled trial to examine the effects of population-tailored and data-driven behaviour change techniques in addition to classic CLTS. It is also the first study to investigate how CLTS promotes latrine construction by changes in psychosocial determinants. The results showed once more that CLTS is powerful in evoking latrine construction, as reported by previous studies (Bongartz et al., 2016; Crocker et al., 2016a; Pickering et al., 2015; USAID, 2018; Venkataramanan et al., 2018). The 67% latrine coverage in the intervention communities, compared to just 7.9% in control communities, is higher than in other CLTS intervention campaigns implemented in Ghana, that have achieved up to 45% (USAID, 2018) or to other sanitation campaigns in different countries that have achieved 30% (Garn et al., 2016). It is comparable to CLTS outcomes in other countries, such as Mali, where CLTS achieved a latrine coverage of 65% or Malawi with close to 100% (USAID, 2018). However, our second hypothesis could not be confirmed: additional campaign activities based on the RANAS approach to systematic behaviour change (Mosler & Contzen, 2016) did not significantly increase the effectiveness of classic CLTS. The results showed non-significantly greater increases in latrine coverage in those communities that received a public commitment intervention alongside CLTS

than in those that only received the classic CLTS. This is surprising in light of previous studies that found highly significant RANAS-based intervention effects in various cultural settings and behavioural contexts, for example on collecting arsenic-free drinking water in Bangladesh (Inauen & Mosler, 2014), handwashing interventions in Burundi (Sonego & Mosler, 2014), shared latrine cleaning in Uganda (Tumwebaze & Mosler, 2015), and disinfecting drinking water in rural Chad (Lilje & Mosler, 2018). One reason that no additional effects were observed for the RANAS interventions is low intervention fidelity. As the implementation protocols of the implementing NGO indicate (see also flow diagram and intervention description), only 42.8% of the interviewed sample received the sticker as sign for their commitment to construct a latrine and a further 12.7% received the flag as a sign of their completed latrine. The household action plan was delivered to 41.5% of our respondents. These figures are rather poor compared to the participation rates in the CLTS triggering event (66.8% for CLTS only). The additional RANAS-based activities might therefore produce greater success if implemented more diligently. Another reason that we did not observe additional effects for the RANAS interventions may be a ceiling effect. As classic CLTS alone promoted latrine construction very powerfully, the RANAS interventions were not able to add to its effectiveness. Further, the interventions were implemented in a specific sequence with classic CLTS being the first. The other three RANAS-based interventions were implemented after completion of the classic CLTS. This was due to the practical challenges of implementing such a large trial. The time from triggering to the follow-up survey was included in the sensitivity analyses and did not yield different results than presented above. However, the RANAS interventions might have worked well as a stand-alone intervention, a point that may be investigated in future studies.

This study is the first to show that changes in people's mindsets are responsible for the intervention effects of CLTS on latrine construction. Following our hypothesis, positive changes in psychosocial determinants caused by participation in CLTS led to higher latrine coverage in the communities.

CLTS made participants more aware of the latrine construction behaviour of their social environment, their families, and their neighbours. CLTS also led to an increased perception that community leaders approve of latrine construction as something desirable. The participants developed greater confidence that they would be able to construct and maintain their own household latrine. They even felt that they would be able to repair a damaged latrine. CLTS strengthened the commitment of its participants to constructing a latrine and fostered the development of an action plan detailing how, when, and with whose help the latrine would be constructed. These changes were all positively related to a higher probability of constructing latrines.

The relevance and effectiveness of changes in social norms for latrine construction, as in our case with others' behaviour and others' approval, have been reported by previous research that showed that CLTS promotes a social movement (Bongartz et al., 2016; Dooley et al., 2016; Harter et al., 2018;

Venkataramanan et al., 2018). A qualitative study revealed the influence of community leaders on the latrine construction process by the implementation of by-laws (Lawrence et al., 2016), as also encouraged by the CLTS handbook (Kar & Chambers, 2008). In the case of Ghana, another randomised trial revealed that training natural community leaders to support the process of latrine construction can positively influence latrine ownership (Crocker et al., 2016a). CLTS was also able to make people feel more confident in constructing and maintaining their own household latrine, and this higher confidence helped them to actually complete this task. This is in line with previous research showing that higher confidence was a predictor of habitual latrine cleaning in Burundi (Sonego & Mosler, 2014) and was also positively correlated with handwashing behaviour in Haiti (Contzen & Mosler, 2013). In our study, CLTS also achieved its goal by strengthening peoples' commitment to latrine construction. Commitment is the driver that transforms a plan into action and within the RANAS model is therefore located in the self-regulation factor block (Mosler & Contzen, 2016). The role of commitment as an important predictor of hygienic behaviour has been shown by previous research in the WASH sector: increased commitment explained improved habitual latrine cleaning behaviour in Burundi (Sonego & Mosler, 2014) and increased handwashing in Ethiopia (Contzen & Inauen, 2015). The greater development of action plans for latrine construction also helped people to construct latrines. Interestingly, CLTS does not implement household-based action plans, working instead at community level (Kar & Chambers, 2008). This still increased people's reporting the possession of an action plan.

Practical implications. The results of the mediation analysis imply that CLTS is already successful but can still be improved. The changes in psychosocial determinants were achieved by identifying and implementing specific BCTs that targeted the determinants required. Those that proved to be successful for behaviour change should be kept. These were based on the RANAS catalogue of BCTs (Mosler & Contzen, 2016) and included those that strengthened the norm factors: the implementation of a public commitment together with a public contract that made commitment visible to all other participants with a sticker (BCT 10). Committed participants were invited to stand in public and the rest of the community, including leaders, clapped for them, so they also gained affirmation of others' approval (BCT 11). The selection and support of natural leaders to serve as role models was successful in strengthening the commitment of participants (BCT 14), as was the agreement to a behavioural contract (BCT 36) that invited people to raise their hands and commit to latrine construction. Further activities that should be repeated in other interventions were those strengthening confidence in performance and maintenance of latrine construction, which in turn was positively correlated with latrine construction. During the triggering event and follow-up visits, latrine options were discussed, technical support was given, and questions concerning the construction process were answered (BCT 18). This included dealing with such difficulties as problematic soil conditions (BCT 25). The influence and positive effect of follow-up visits has been widely discussed and practically acknowledged (Venkataramanan et al., 2018). At both community and household levels, specific action plans defined when, how, and

with which materials the latrines should be constructed (BCT 26). This planning activity helped people to perform the construction and should be repeated at least at community level.

Further improvements in CLTS are most likely to result from addressing the psychosocial determinants whose changes were positively related to latrine construction but which were not changed by the interventions. These were Vulnerability, Severity, and Barrier planning. The RANAS approach offers BCTs for these specific determinants that can be adapted to the context. For instance, when drawing the communities' open defecation map, the personal risk to each participant of getting diarrhoea should be stressed (BCT 3), perhaps by measuring the distances on the map of each household from the open defecation area. This is also proposed by the *CLTS Handbook* (Kar & Chambers, 2008). To raise participants' awareness of the severity of diseases, calculating the households' medicals expenses arising from diarrhoeal diseases may be used more strictly (BCT 5). People who showed an increase in barrier planning were more likely to construct a latrine, but this was not achieved by the CLTS intervention. Facilitators should treat possible doubts and problems arising during the construction process carefully and provide possible solutions together with either natural leaders or the individual households (BCT 30).

Strengths and limitations. The study has several limitations. All data concerning psychosocial determinants and outcome variables were self-reported. An objective measure for latrine construction was gained through the observations of the data collectors. This showed strong agreement between observed and self-reported latrine construction, so the self-reported data was used.

Another limitation concerns conclusions about the nature of the mediating effects. Due to the experimental design, causal conclusions on the changes in psychosocial determinants are likely. However, the causal nature of the relationship between changes in psychosocial factors and latrine constructions cannot be established with our data. In our study, the psychosocial determinants and latrine construction were both measured at the same time. Assessing psychosocial determinants before latrine construction may strengthen causal conclusions somewhat. However, more experimental research (e.g. manipulating the determinants Others' behaviour and Vulnerability to test effects on latrine construction) is ultimately needed to provide conclusive tests of the causality of these relationships.

The success of CLTS in this study only accounts for the way CLTS was implemented by Global Communities for this project. The CLTS approach is meant to be adapted to local conditions and needs and therefore shows great variation between implementing organisations.

The study also has several strengths. This project is one of the first fully-powered cluster-randomised trials on CLTS. It therefore provides strong evidence for the success of CLTS. With 25 clusters and 625 individuals on average for each of the five intervention arms, the sample size of 3216 households allows unusually robust and reliable statistical analysis. Multilevel analysis was able to reveal and best

account for the heterogeneity between and within communities. Cluster randomization is another strength that serves the external validity of our findings and prevents community differences interfering with intervention effects. In this research project, CLTS was implemented in a variety of community and physical contexts. The success of CLTS across all the conditions within this study offers strong encouragement to scale implementation up to other regions of Ghana and even to other countries in West Africa.

In addition, this study was the first to examine the psychosocial mechanisms of CLTS. The need to examine in greater detail the mechanisms of behaviour change interventions has recently been emphasized by the National Institutes of Health (Nielsen et al., 2017). As our study demonstrates, these results can provide important insights into how an intervention works and how it can be improved.

This is the first longitudinal study that investigated how CLTS promotes latrine construction. Using mediation analysis, the results provided interesting insights into the psychosocial mechanisms of CLTS's effectiveness. The results provided compelling evidence that CLTS can promote latrine construction and that it can change several psychosocial factors determining behaviour change. The model also indicated that changes in these determinants are related to increased latrine coverage.

4.6. Acknowledgements

This project was made possible with funding of the Bill and Melinda Gates Foundation (ID OPP1116717) and in cooperation with USAID. Eawag Switzerland provided infrastructure and scientific advice throughout the process. Research and intervention implementation were realized in close collaboration with the country office of Global Communities in Accra and the regional office in Tamale, Ghana. We especially thank Alberto Wilde and Dominic K. Dapaah (Global Communities, Ghana) for support and the coordination and organisation of the intervention campaigns together with all implementing facilitators. We thank the two District Assemblies for their broad support in this research project. Special thanks to Jonathan Nanyim Kumah and Aduah Josiah Ayipaala (Global Communities), who showed greatest commitment as district coordinators for the CLTS implementation. We thank our field supervisors Abdulai Baba Seidu, Joshua Kpan, Cornelius K.A. Pienaah, Lazarus Jambadu, Stephen Kuunibe, John Balankoo Sumbo, Abraham M. Nunbogu and Albert Dongzaglah. We further thank our colleagues Sebastian Mosch, Eva Seumer and Innocent K. Tumwebaze, our interns Saskia Engel, Nicole Frank, Max Schneider and Alexander Mewes, as well as our master students Seraina Huder and Vica Tomberge, for their dedication and irreplaceable support during the field surveys. We thank our data collectors and all study participants in Bole and Sawla-Tuna-Kalba districts

5. The role of social identity for achieving an open-defecation free environment: A cluster-randomised controlled trial of CLTS in Ghana.

Miriam Harter, Nadja Contzen, Jennifer Inauen

A similar version of this chapter is submitted for publication.

5.1. Abstract

Unsafe sanitation practices contribute majorly to environmental pollution and are a leading cause of death in developing countries. A shift in social norms could motivate people to stop open defecation. Creating social norms opposing open defecation is a key strategy of the sanitation campaign "Community-Led Total Sanitation" (CLTS). Based on social identity theory, we expect CLTS to be most effective in communities with stronger social identity, because in these communities individuals should rather follow social norms. We conducted a cluster-randomised controlled trial with 3,216 households in 134 communities in rural Ghana, comparing CLTS to a control arm. Self-reported open defecation rates and social identity were assessed pre-post. Generalized Estimating Equations showed that CLTS achieved lower open defecation rates compared to controls. This effect was stronger for communities with higher average social identity (B[SE]= 11.70 [4.15], p= 0.005). The results imply that pre-conditions need to be considered for planning and if needed social identity strengthened.

5.2. Introduction

Annually, 9 million people die due to environmental pollution (Landrigan et al., 2017). Unsafe sanitation, and more specifically open defecation, is one of the main causes, leading to faecal contamination of water bodies and the transmission of faecal bacteria (Prüss-Ustün et al., 2014) (Landrigan et al., 2017). In 2015, 892 million people still practiced open defecation (WHO and UNICEF (2017)). A recent systematic review found that increasing access to safe sanitation services can reduce diarrheal diseases by 16% (Wolf et al., 2014). However, a single individual or household, by stopping open defecation, can only marginally reduce their diarrheal risk related to a faecal polluted environment. Research has shown that at least 75% of all members have to stop open defecation to achieve a hygienically safe environment, which benefits all (Clasen, Boisson et al. 2014, Jung, Hum et al. 2017, Wolf, Hunter et al. 2018). Open defecation therefore is not only an individual, but also a collective health hazard (Geruso & Spears, 2018; Vyas et al., 2016). This is comparable to other environmental challenges, as for example climate change, which can only be confronted if the majority of the population shows climate-protective behaviour.

Activating the social norm supporting the expected behaviour helps people to act pro-environmentally (Bamberg & Möser, 2007; Steg & Vlek, 2009). This has been found for example concerning littering in public places (Cialdini et al., 1990), household energy conservation (Schultz et al., 2007) or the sustainable use of safe water resources (Contzen & Marks, 2018). Similarly, activating social norms has been used in the context of sanitation. It is a key element of the behaviour change campaign Community-Led Total Sanitation (CLTS), which has been shown to successfully stop open defecation (Crocker et al., 2016a; Pickering et al., 2015). CLTS consists of a set of community-based, participatory activities, and explicitly focuses on evoking a shift towards a new social norm opposing open defecation. The influence of CLTS on social norms and thus the effect on latrine construction has already been demonstrated in research (Alemu et al., 2018; Harter et al., 2018) and the consideration of social norms

for the success of CLTS is gaining more attention (Dooley et al., 2016; Novotný et al., 2017; Venkataramanan et al., 2018). Because of its success in stopping open defecation, CLTS is the most widely applied sanitation campaign to date (Bongartz et al., 2016; USAID, 2018).

While randomised trials have shown that CLTS reduces open defecation compared to controls, these effects are highly heterogeneous (Harter et al., in review). This means that despite the general success of CLTS, open defecation rates remain high in some communities, and the threshold of 75% latrine coverage is not reached everywhere (Crocker et al., 2016a; Pickering et al., 2015; Venkataramanan et al., 2018). This indicates that inter-community differences may moderate CLTS effectiveness.

A plausible moderator that might be at play here is social identity, defined as an individual's understanding to belong to a social group and to emotionally value the membership (Abrams & Hogg, 1990; Reynolds et al., 2015; Tajfel, 1978). If social identity is low, community members may not be inclined to follow the introduced social norm, and hence will not stop practicing open defecation. In support of this, previous research has shown that social norms particularly affect behaviour in individuals strongly identified with the social group in question (e.g. (Terry et al., 1999; White et al., 2009)). One potential explanation for this effect is that strongly identified people want to be accepted and approved by their group, and may thus be eager to conform with the group's expectations, independent of whether they agree with a specific social norm or not (Abrams & Hogg, 1990; Deutsch & Gerard, 1955). Regarding CLTS, households may construct and use a latrine not because they are convinced of it, but simply because they want to be accepted in the community and therefore conform to the newly established social norm. The social identity perspective, however, proposes an alternative explanation (Tajfel & Turner, 1979; Turner et al., 1987). Self-categorization as a group member (i.e. the definition of the self in group-terms and in connection to other group members) includes a merging between group and individual; group goals become personal goals and group norms become personal norms. Accordingly, strongly identified members act in line with group norms not only because they want to conform but more so because they perceive the norm (e.g. of constructing and using latrines) as their personal norm, as their right way (Abrams & Hogg, 1990; Deutsch & Gerard, 1955).

We therefore expect that CLTS will be especially successful in reducing open defecation in communities with stronger social identity prior to CLTS implementation because people will more readily follow the newly established social norm to stop open defecation. At individual level, we expect that people who feel a higher social identity then the mean of their community more likely stop open defecation. To test our assumptions we conducted a cluster-randomised controlled trial, which is outlined in the following.

5.3. Methods

For this cluster-randomised, controlled trial, four different versions of CLTS were implemented and effects on open defecation reduction were tested and compared to one control arm[2]. Social identity prior to the intervention was tested as a moderator of CLTS' effectiveness.

Procedures. We collected baseline data in February to March 2016. Afterwards, Global Communities, a local non-government organisation, implemented interventions in July to November 2016. A mid-term follow-up survey was conducted four to six months after implementation, in February to March 2017 (the effects are reported in Harter et al., under review). This article presents data from the long-term follow-up that was realized 14-16 months after implementation in February to March 2018. The ethical board of the University of Zurich, Switzerland and the Ethical Review Committee of the Ghana Health Service (GHS-ERC: 05/01/2016) approved this research trial and according materials.

Study site and clusters. The study was realized in two districts of the Northern Region of Ghana in collaboration with Global Communities, and local governmental representatives. Global Communities selected the two districts, Bole and Sawla-Tuna-Kalba, because no CLTS campaign had been implemented there before. The local governmental representatives selected 132 communities within the two districts according to two eligibility criteria: accessibility (by car or motorbike due to practical reasons) and community size (minimum cluster size of 25 households). We grouped the communities into 25 regional clusters and allocated them randomly to each of the five different intervention arms (i.e. 5 clusters per arm).

Participants. Trained data collectors selected participating households in the communities following the random route method (Hoffmeyer-Zlotnik, 2003). Data collectors were instructed to start from a central point of the community and interview every third household in an assigned area of the community. If the household did not match selection criteria or no one was at home, data collectors selected the next following household. Participants were eligible if aged 18 or older and stable inhabitants of the community. We equally considered men and women, as both might take important decisions for latrine construction. Every participant gave informed written consent to participate in the interviews.

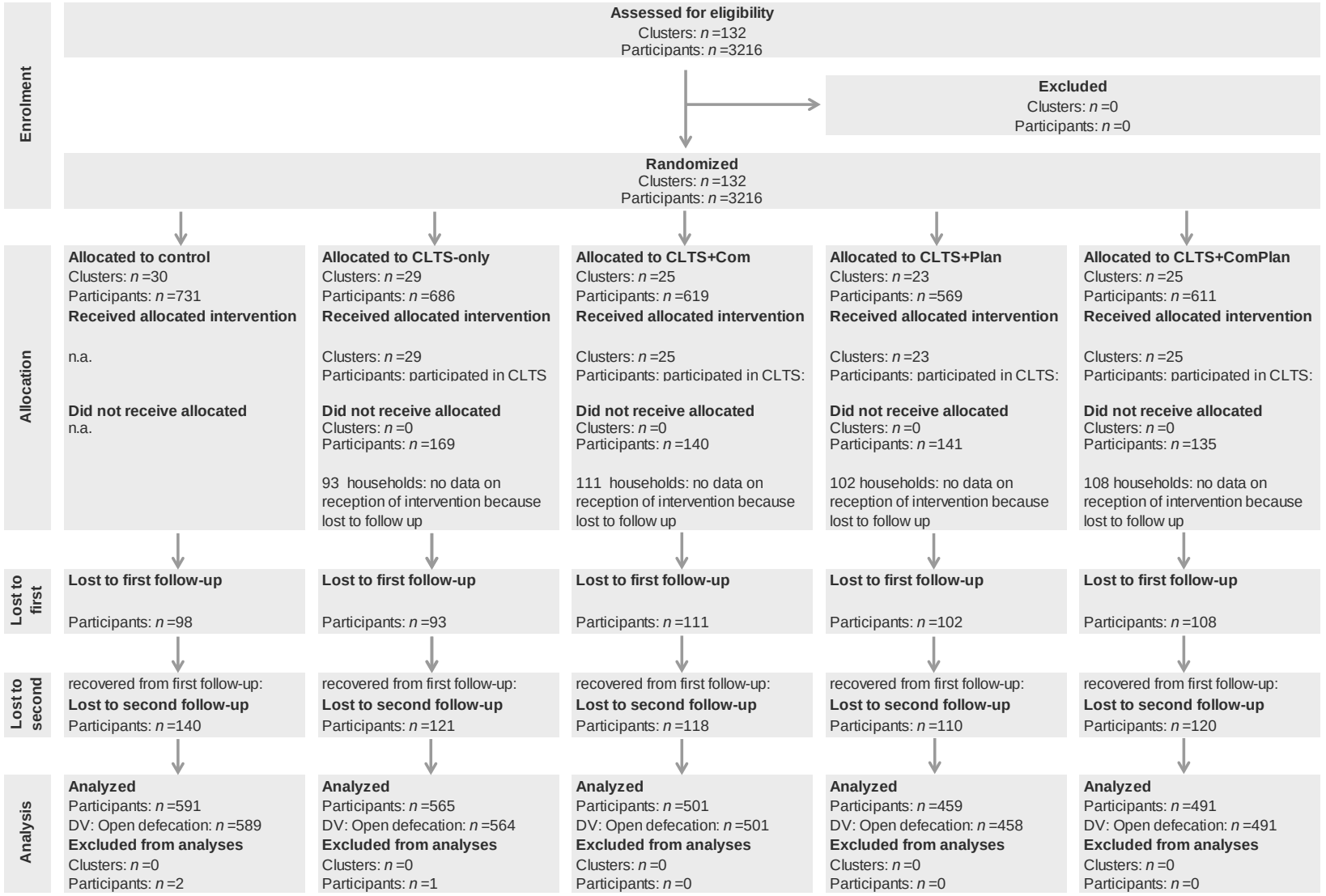
The sample size of 3,215[3] households (25 communities with 25 households each) was calculated a priori for a multilevel and repeated study model with a cluster-randomised design (Spybrook et al., 2011), that

[2] Similarly to the analysis of the mid-term follow-up data (Harter et al., under review), the analysis of long-term follow-up data showed no differences in intervention effects on open defecation frequency between the four intervention arms. For this article, the different CLTS intervention arms were therefore combined for analysis.
[3] Final sample consisted of 3,216 households and exceeded the calculated sample size by 91 cases. The reason was that during the baseline survey, some communities revealed to have less households than the expected 25 and new communities were included to still meet the target of 3125 households. In the new communities, again 25 households were interviewed, if possible.

accounted for the dichotomous outcome variable open defecation, an expected drop-out rate of 20%, assumed 80% power, 0.05% α-error probability and intra-cluster correlation of ρ=.2 (for a detailed description of sample size calculations, please refer to Harter et al., under review). Intra-class correlations are reported in Table 5.1. For both individual and cluster levels, Figure 5.1 displays the sample size in the flowchart of the sample.

The respondents were on average 44.5 years old (*SD*= 16.13), slightly less than half were female (42%) and 21% were able to read and write. The households consisted of eight members on average (*SD*= 5). In terms of religion, 26.2% named Islam as their religion, 49.2% Christianity and 19.2% traditional religions, 5.4% mentioned to be atheists. The majority of the sample reported to be farmers (80.4%) with an average monthly income per household of 202 Ghanaian New Cedi (*SD*= 380, equivalent of 42 USD. The households of the sample therefore lie on average below the poverty line proposed by the World Bank of 57 USD per individual per month (Atkinson, 2017)).

Interventions. Global Communities developed intervention protocols for CLTS based on the Handbook on CLTS (Kar & Chambers, 2008). Local facilitators implemented it in three phases. First was an informative phase, where facilitators visited the community and collected information on the composition of the community and the baseline behaviour. A date for a community meeting was agreed and all inhabitants were invited. The community meeting, also called triggering event, formed the second phase of CLTS. During this meeting, the facilitators motivated community members to draw a map of their community on the ground and to indicate their houses as well as the spots they use for open defecation on the map. Through asking questions about possible ways of faecal-oral transmission of pathogens, the inhabitants were expected to recognize the hygienic problems connected to open defecation. The facilitators further identified emerging leaders during the triggering event and invited them to serve as role models and to support others in the process of latrine construction. A community action plan and a date on which the community wanted to be open defecation free (ODF) was agreed. In the end of the triggering event, the facilitators explained the first step of a latrine construction, namely digging the pit and gave further information on the construction process, such as which material to use. The third phase of CLTS included follow-up visits in the weeks after the triggering event until the community reached the status ODF, defined as at least 80% latrine coverage. During the follow-up visits, facilitators addressed any arising problems and questions regarding latrine construction. CLTS was implemented in all four intervention arms.



Note: DV=Dependent variable. No clusters were lost to follow-up.

Figure 5.1: *Sample flow chart*

For three of the intervention arms additional campaign activities were developed and implemented based on the Risk, Attitudes, Norms, Abilities and Self-regulation (RANAS) approach (for detailed description of implemented interventions and outcomes please revise Harter et al., under review). They included a household action plan and a public commitment for latrine construction. The control arm did not receive any intervention during the research phase but CLTS was implemented after the trial. In intervention communities, 72.8% (n= 1540) of the households attended the CLTS event. Interested readers may request the protocols of the additional interventions with the corresponding author or consult NN, 2018 for full description of the intervention implementation.

Data collection and outcome measures. A team of 33 local data collectors assessed outcome variables at baseline and both follow-ups. The first author, together with local personnel trained the team in a 1-week training before each of the three data collection phases. The trainings included the detailed discussion of questionnaire items, which were translated into seven local languages during the first training, and explained the correct usage of instruments and interview techniques. These were then rehearsed in role-plays. The questionnaire was pretested in two days and 66 interviews prior to each data collection in the field. Every interview was supervised (by research managers, interns, master students and local field supervisors), and lasted 50 minutes on average. Interviews included self-reported behavioral measurements, social identity, and further items on psychosocial determinants of behavior (not relevant to the present paper).

Based on the Safe San Index (Jenkins et al., 2014), six items assessed the self-reported open defecation rate of the individual's defecation practices during the last week (The original Safe San Index includes information of the whole household, whereas for this article only individual self-reported behavior at long-term follow-up was considered). Three items asked for the open defecation frequency in the mornings, middays and evenings/nights of the last week and three items asked the same for latrine use (items displayed in annex II Table 6). The Safe San Index represents a proportion of safely managed feces relative to total defecation instances, resulting in a figure of 0-1 resembling the proportion of safely managed feces per individual. However, data revealed that individuals either exclusively practiced open defecation or used a latrine. This resulted in a binary outcome variable with 0 = no open defecation and 1 = open defecation. Aggregated to community level it accounts for a communities' average open defecation rate, the proportion of people within one community, who reports to practice open defecation (0-100%).

Social identity at baseline was measured on three dimensions: in-group ties, in-group affect and centrality following items proposed by Cameron (2004). The selection of two items per dimension for this research was done in accordance with local partners, based on cultural and language considerations. Items were framed as statements with a five-point Likert-type scale for agreement. We used a visual scale with five black dots (in ascending order relative to their size) to help respondents choose one of the answer options. The data collector read out every answer option to the respondent and pointed it out

on the visual scale. To test the items' factor structure, we conducted an exploratory factor analysis with Principal Component Analysis and Varimax rotation with Kaiser Normalization (Field, 2009) (correlations displayed in Annex II Table 4). The factor analysis resulted in one factor for social identity with the items of the two dimensions in-group affect and centrality loading on the factor. The four items were aggregated to one scale (M= 4.29, SD= 0.30, Cronbach's α= 0.64). Table 5.1 displays the four items of the scale and according descriptive measures, correlations and intra-class correlation. Aggregated at the community level, it resembles a community's average social identity.

Analyses. To test the moderating influence of social identity on the effect of CLTS on open defecation, we fitted a Generalized Estimating Equation (GEE) model with logistic link (Zeger & Liang, 1986; Zeger et al., 1988) using IBM SPSS Statistics for Windows, version 24 (IBM Corp., Armonk, N.Y., USA). The model was set up using binomial distribution and an exchangeable correlation structure (Homish et al., 2010). This model accounted for the nested structure of our data with households nested in communities and further allowed the inclusion of a binary outcome (0= no open defecation vs. 1= open defecation). The CLTS intervention (0 = control arm; 1 = intervention arms) was entered together with the grand-mean centered community's average social identity and the individual's deviation from the community's average social identity (group-mean centering). Thereby, we were able to distinguish between community-level and individual-level effects, which may differ (Hamaker, 2012)). We further added the interaction terms of the intervention with social identity at both, individual and community level, to test whether social identity moderated the intervention effect on reported open defecation. As effect size measures, we calculated odds ratios (ORs) with asymptotic Wald 95% confidence intervals (CIs).

Table 5.1: *Descriptive measures, correlations and intra-class correlation for items of the social identity scale*

		Cron-bach's α	P (ICC)[b]	*n*	*M*	*SD*	*r*		
							1	2	3
Social identity scale items		0.64	.11	3,216	4.28	0.30			
Centrality	I often think about the fact that I am a member of this community.			3,216	4.16	1.17			
	In general, being a member of this community is an important part of my self-image.			3,216	4.29	0.99	0.42**		
In-group Affects	In general, I am glad to be a member of this community.			3,214	4.46	0.92	0.33**	0.58**	
	I do not feel good about being a member of this community. [a]			3,216	1.81	1.31	0.15**	0.23**	0.31**

Note: Items based on Cameron (2004). Items measured on a five-point Likert-scale: 1= agree not at all to 5= agree very much. Significance levels: $^{**}p < 0.01$. *SD*= standard deviation. P (ICC)=Intra-class correlation. *r*=Pearson correlation. [a] item recoded.

5.4. Results

Randomization check and dropout analysis. Table 5.2 shows baseline characteristics for intervention and control arms. The groups significantly differed on all characteristics except for age, household size and number of dropouts, which were equally distributed. At baseline, 89.9% of the control and 97.2% of the intervention arm reported to practice open defecation. Even though the effect sizes were small (Cohen, 1992; Ferguson, 2009; Trusty et al., 2004), all relevant confounding variables were included in sensitivity analyses.

Furthermore, we compared dropouts (*n*= 609, 18.9%) to respondents who remained in the sample (*n*= 2,607) on the same characteristics. The dropouts were significantly less likely to be farmers, had a higher probability for literacy, were significantly younger and had a higher income compared to analysed participants (see Annex II Table 5).

Table 5.2: *Baseline sample characteristics for intervention and control arms*

	Control Group	Intervention	*Cramer's V*	*p*	
n	740	2476			
Occupation			0.188	<.001	
farming	66.3%	84.5%			
other (trading, fishing)	33.7%	15.5%			
Religion			0.193	<.001	
Islam	39.4%	22.1%			
Christian	43.5%	51.0%			
Traditional religion	13.4%	20.9%			
Atheists	3.6%	6.0%			
Female respondents	50.4%	40.2%	0.087	<.001	
Ability to write	25.1%	19.8%	0.055	.002	
Dropout	80.4%	81.3%	0.009	.603	
Open defecation rate	89.9%	97.2%	0.148	<.001	
	M (SD)	*M (SD)*	*F*	*p*	*d*
Age	44.39 *(16.30)*	44.58 *(16.08)*	0.06	.805	0.01
Income	268.65 *(530.55)*	183.21 *(320.16)*	28.13	<.001	-0.2
Household size	8.42 *(4.63)*	8.80 *(4.92)*	3.30	.069	0.08
Social identity	4.24 *(0.80)*	4.28 *(0.76)*	4.79	.029	0.04

Note: Effect sizes for independent means according to Cohen (1992): *d*=.2 (small), *d*=.5 (medium), *d*=.8 (large) and for Cramer's *V*: *V*=.1 (small), *V*=.3 (medium), *V*=.5 (large) (Ferguson, 2009).

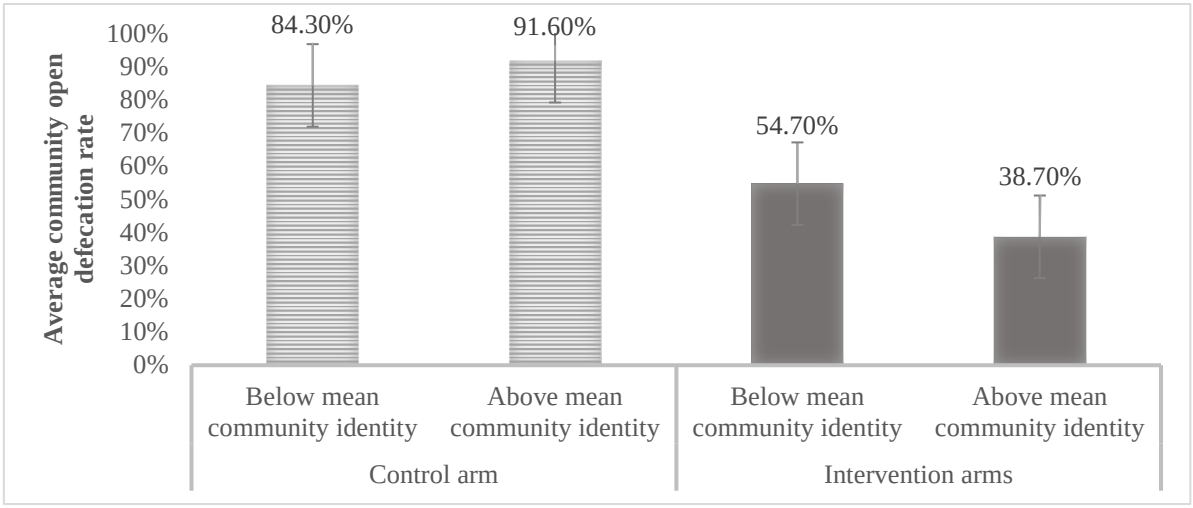
Intervention effects on open defecation and the influence of social identity. In the CLTS intervention arms, 46.4% (*SD*= 49.9%) of the individuals reported to practice open defecation, compared to 88.4% (*SD*= 32.0%) in the control arm. As indicated by the GEE model results (see Table 3), the intervention group was 11 times less likely to practice open defecation at follow-up than controls (*B[SE]* = -2.42 [0.33], *OR*= 0.09, *p* <.001).

Figure 5.2 shows the community-averaged open defecation rate in control and intervention arms moderated by community's average social identity. According to our hypothesis, CLTS intervention communities with social identity above average, reported less open defecation at follow-up than those with social identity below average (*B[SE]*= -11.70 [4.15], *p*= 0.005). The control arm showed opposite effects: communities with social identity above average, reported higher open defecation rates at follow-up than those with social identity below average (*B[SE]*= 7.06 [2.28], *p*= 0.002). In both the control and intervention arm, the effects of individuals' social identity pointed in the same direction as the community's average social identity, but were not significant (control arm: *B[SE]*= 0.25 [0.24], *p*= 0.305; intervention arm: *B[SE]*= -0.65 [1.05], *p*= 0.534). Sensitivity analyses revealed that including the baseline characteristics, and adjusting for baseline behaviour, did not substantively change the findings. Only age and literacy had significant but small reducing effects on open defecation (age: *B[SE]*= -0.01 [<0.01], *p*= 0.002; literacy: *B[SE]*= -0.27 [0.10], *p*= 0.008).

Table 5.3: *Parameter estimates for Generalized Estimating Equation of intervention main effects and interaction effects with social identity on open defecation at follow-up*

				95% Wald Confidence Interval for OR	
	B (SE)	*p*	*OR*	LL	UL
(Intercept)	0.24 *(0.16)*	0.145	1.27	0.92	1.74
Effect of CLTS compared to control arm[a]	-2.42 *(0.33)*	<0.001	0.09	0.05	0.17
Effect of individual social identity in control arm	0.25 *(0.24)*	0.305	1.28	0.80	2.06
Effect of community's average social identity in control communities	7.06 *(2.28)*	0.002	1169.42	13.52	101186.42
Interaction effect of individual social identity with CLTS	-0.65 *(1.05)*	0.534	0.52	0.07	4.08
Interaction effect of community's average social identity with CLTS	-11.70 *(4.15)*	0.005	<0.01	<0.01	0.03

Note: N=2606, *B*= unstandardized regression coefficients. *SE*=Standard error. *OR* = Odds ratio. *LL*= Lower level, *UL*=Upper level. Probability distribution: binomial, link function: logit. All *p*-values are two-tailed. Outcome (self-reported): 0= no open defecation, 1=open defecation. Social identity was group-mean centered (individual) and grand-mean centered (community level). [a] CLTS: 0=control arm, 1=CLTS interventions.



Note: Reported average community open defecation rate: open defecation (coded = 1) vs. no open defecation (coded = 0) aggregated at community level.

Figure 5.2: *Intervention effects on average community open defecation rate depending on community's average social identity*

5.5. Discussion

This study showed for the first time that social identity within communities moderates the effectiveness of CLTS on open defecation. It also corroborated previous findings that CLTS is a powerful intervention to reduce open defecation. In our sample, at the long-term follow-up 53.6% of individuals in intervention arms did not defecate in the open any more. While this rate is still behind the threshold of 75% that would need to stop open defecation to reach an incremental health benefit at community level (Jung et al., 2017a; Wolf et al., 2018), it is comparable to most randomised trials of CLTS. A

recent review on CLTS reports that the majority of interventions achieve around 50-80% rates of stopping open defecation (USAID, 2018).

That the reported rate in our study is at the lower end, can partly be explained by the time elapsed between intervention and follow-up survey. At the time of the survey, many latrines (62%) were still under construction and therefore still not in use. In the intervention arm, the figure of 46% of the respondents that reported to practice open defecation, might likely decrease as soon as the construction process of the remaining latrines is completed. We expect this, because in our sample the vast majority of households that owned a completed latrine also used it (94%). This is surprising when compared to previous research on latrine ownership and use, for example from India, where it was found that only 47% of the owned latrines were actually used (Barnard et al., 2013a).

Our hypothesis regarding the influence of social identity on the intervention effects was supported: CLTS was more successful in communities with stronger social identity prior to the intervention. In communities with average social identity higher than the overall mean, 39% of respondents reported to practice open defecation, compared to 55% in communities with lower social identity. Comparing communities of controls with intervention arms both with social identity above the average, the intervention yielded 53% less open defecation in intervention communities. Our findings add to those of a randomised trial on CLTS in Indonesia on the importance of communities' pre-existing social conditions for intervention success (Cameron et al., 2015) . The researchers were able to show in a randomised trial, that communities with higher initial social capital, i.e., higher trust and cohesion, were more likely to have higher latrine coverages.

Unexpectedly, our data showed opposite effects in control communities: higher reported open defecation rates were observed in communities with higher social identity compared to those with lower social identity. This might be, because in communities without CLTS intervention, the social norm was still positive towards open defecation, no impulse of change had occurred. This finding supports social identity theory; communities with higher average social identity follow the norm, whether it is the one of stopping open defecation -as in intervention communities-, or the opposite -as in control communities- (Cialdini et al., 1990). Schultz et al. (2007) described this effect of a salient norm that leads to an undesired behaviour *"the destructive potential of social norms"*. A departure from a prevailing social norm, as stopping open defecation in communities without CLTS, may only be possible for community contexts where social identity is low, i.e., where being accepted by other community members is not a primary need (Abrams & Hogg, 1990; Deutsch & Gerard, 1955).

Finally, our data point into the direction of no additional effects of individuals' deviations from the community social identity. It seems that the effect of social identity is a truly community-based phenomenon.

We suppose that our findings of the moderating effect of community social identity on CLTS outcomes work through a shift in social norms that opposes open defecation. In communities where individuals strongly identify with their social group, the wish to conform to the new norm will lead to better CLTS outcomes (e.g. (Terry et al., 1999; White et al., 2009)). People conform to the norm, not necessarily, because they think this is the right way to go, but rather because they want to be approved and accepted by fellow community members (Abrams & Hogg, 1990; Deutsch & Gerard, 1955). In addition, social identity theory goes even further and postulates that strongly identified individuals not only conform to the norm, but also transform it into their own goals and personal norms. However, this assumed mechanism of CLTS, evoking a shift in social norms and people transforming group norms into personal norms, which then leads to higher reductions of open defecation was not tested in this analysis and should be set on future research agendas.

To sum up, our results highlight the importance of considering the strength of community social identity especially when targeting collective environmental challenges, such as open defecation. This fact, of considering the social context in CLTS planning and implementation is gaining more attention (Dooley et al., 2016; Novotný et al., 2017; USAID, 2018).

For the implementation practice, this means that communities with strong social identity provide a fertile ground for CLTS implementation. To improve CLTS planning, we therefore suggest a thorough assessment of social identity in a first step. If social identity is found to be low, activities should be carried out to foster social identity prior to CLTS implementation, as has been recommended for the field of collective action (Van Zomeren et al., 2008). Such activities might include enabling interaction between community members (Jans et al., 2015) or directing attention to neighbouring communities that have already eliminated open defecation, thus forming a competition-like situation and pointing out the differences to an out-group (Jans et al., 2018; Tajfel & Forgas, 2000). In cases, where social identity cannot be strengthened before a CLTS implementation, by-laws or sanctions for people not following the norm might be enforced, which is proposed by the CLTS Handbook (Kar & Chambers, 2008) and in social psychology literature to solve social dilemma situations (De Cremer et al., 2012).

Strengths and limitations. To the best of our knowledge, this study is the first that investigated the influence of social identity on the effect of CLTS on latrine use. It was fully powered with a sample of 2,606 households for the follow-up survey and 3,216 households in the baseline. With 132 communities, it allowed analysis at the community level, and the investigation of the deviation of individuals from community means. CLTS was implemented under real conditions in rural Ghana in a variety of local contexts, such as different community sizes and ethnical compositions. This allows assuming high external validity.

The study, however, has the following limitations. One relates to the causal relationship of social identity moderating CLTS intervention effects. Because we did not experimentally manipulate social

identity, the found moderating effect could be attributable to other influencing factors, for example community size or heterogeneity within communities. Future research should manipulate the strength of social identity to provide further evidence for the presented moderating effects in this article.

Open defecation was assessed through self-report, which can be seen as a further limitation. However, strengthening the validity of the self-report measure, the use of latrines was verified by observation of enumerators[4], which correlated strongly with the self-reported behaviour (r^2= .72, p<0.001).

Social identity was measured using six items and for analysis, four items were included. However, items showed low reliability (Cronbach's < 0.7). Furthermore, the four items used for the social identity scale applied in this article did not differentiate the three dimensions of social identity postulated by Cameron (2004). The reason for this may be that only two items per dimension were included to keep the questionnaire as brief as possible to minimize participant burden. Future studies should use more items to allow for a more detailed consideration of social identity dimensions.

Conclusion. This study corroborates the mechanisms assumed by social identity theory, as effects of CLTS have been intensified by the strength of social identification within communities. The relevance of considering social identity in improving sanitation conditions can be transferred to other behavioral targets within the water and sanitation domain or generally to contexts where behavior change of a collective is required, as for example to cope with climate change.

5.6. Acknowledgements

We are grateful to the Bill and Melinda Gates Foundation for the funding of this cluster-randomised controlled trial (OPP1116717). Special thanks to Prof. Dr. Hans-Joachim Mosler for his scientific and practical guidance throughout the whole project and for reviewing this article. We thank Global Communities, Ghana, for the implementation of the different intervention arms and the vast support during our data collection phases. Special thanks to all our collaborators, field coordinators, data collectors, interns and master students, for their irreplaceable contribution to the success of this research. We thank all our respondents in the Northern Region of Ghana for their repeated participation in our interviews.

[4] Enumerators did short observational spot-checks on the latrines and assessed the level of construction and signs of use, such as cleansing material.

6. Overall discussion

This thesis aimed at gaining a deeper understanding of the mechanisms of CLTS, its processes and effectiveness on eradicating open defecation. It further aimed at improving CLTS based on empirical evidence. The empirical chapters of this thesis presented above used different approaches to uncover mechanisms underlying CLTS' processes. All three approaches used data from a cluster-randomised and controlled trial implementing and evaluating CLTS in Ghana. The first one (Chapter 3) tested the contributions of different components of the CLTS implementation process for the intervention's success at community-level latrine coverage. The second one (Chapter 4) compared CLTS alone to CLTS combined with three theory-based and population-tailored intervention activities based on the RANAS-approach to data-driven behaviour change campaigns (Mosler & Contzen, 2016), testing potential improvements. The study further investigated which changes in psychosocial determinants mediated the intervention effect on latrine construction. The third empirical chapter (Chapter 5) tested social identity as a potential moderator of the intervention effect of CLTS on stopping open defecation.

In the context of complex interventions, such as CLTS, it has been recommended to avoid "Reducing a complex system to its component parts [because this] amounts to irretrievable loss of what makes it a system" (Hawe et al., 2004) or in other words: the whole is more than the sum of its parts. The aim of this last chapter of this thesis therefore is to combine the findings of the empirical chapters with previous findings and existing literature to create an overall understanding of CLTS, which "sets the parts of CLTS together to understand the *more* of the whole picture".

This will be achieved by first summarizing the results (6.1), and debating implications from the empirical findings for outcomes of CLTS (6.2.1), for the implementation process of CLTS (6.2.2), for psychosocial mechanisms that underlie the intervention effect (6.2.3) and for factors explaining different responses of communities to the intervention (i.e., moderators) in section 6.2.4 Ultimately, the discussed implications are combined into an integrated model of CLTS (6.3) and directions of future research are pointed out. The last sections discuss strengths and limitations of this thesis (6.4) and ends with a general conclusion and practical implications of this thesis (6.5).

6.1. Summary of findings

This section summarises the findings of the three empirical chapters for each research question. Table 6.1 presents an overview of the study results. In all preceding chapters, findings were integrated in existing literature and previous findings. This will not be repeated in the present chapter.

In Chapter 4, the coverage of study households having constructed a latrine was compared in communities with and without CLTS intervention. In response to research question 1, **does CLTS motivate participants to construct latrines?** the results corroborated previous findings of the effectiveness of CLTS and showed that in communities that received a CLTS intervention, at first

follow-up 4-6 months after implementation, 65.5% had either a completed latrine or started construction, compared to 7.9% in control communities.

Research question 2, **does CLTS motivate people to stop open defecation?** was answered by Chapter 5 which added further evidence to the successfulness of CLTS**.** It revealed that one year after CLTS implementation, in intervention communities, 46% of the sample reported to practice open defecation, compared to 88% in control communities. Section 6.2.1 of this chapter further discusses implications of these findings for the outcome measurement of CLTS in this sample.

In response to research question 3, **what are the contributions of different implementation factors to the success of CLTS on community's latrine coverage?** Chapter 3 identified four influential factors that predicted latrine coverage in communities. Those were the expectation of CLTS-participants to receive an incentive for latrine construction, followed by the number of follow-up visits of the facilitator, the number of selected natural leaders and the attendance rate of communities at CLTS triggering events. Section 6.2.2 further discusses the findings of the implementation process of CLTS.

In addition to the effectiveness of the CLTS intervention arm, Chapter 4 answered research question 4, **is CLTS combined with a theory-based intervention more effective in evoking latrine construction than CLTS alone?** The presented results showed that CLTS in any combination (alone or with public commitment or household action planning) was effective in changing people's behaviour, but that intervention effects did not significantly differ from each other. Additionally, Chapter 4 revealed that communities significantly varied in their response to the interventions, which was true for all of the four intervention arms. The discussion of the improvement of CLTS by combining it with RANAS-based activities is added to section 6.2.1.

In response to research question 5, **which psychosocial mechanisms of the RANAS model mediate the effect of CLTS on latrine construction?** Chapter 4 revealed which psychosocial determinants of the RANAS model were positively targeted by the intervention and which of them significantly influenced behaviour change. Five psychosocial determinants showed to mediate the intervention effect: descriptive norm, injunctive norm, action planning abilities, self-efficacy (including maintenance and recovery self-efficacy) and commitment (combined with personal norm). The RANAS factors vulnerability, severity, and coping planning showed positive relations to the probability to construct latrines, but were not affected by the CLTS interventions. Section 6.2.3 debates on the psychosocial factors of CLTS and future directions for a better understanding of underlying mechanisms.

In response to research question 6, **does social identity moderate the effect of CLTS on open defecation?** Chapter 5 demonstrated that CLTS was more successful in stopping open defecation in

communities with higher social identification. This moderating effect was only found at the community level, but not at individual level. The same accounted for control communities, where the effect was opposite: communities with higher social identification showed higher open defecation rates. Section 6.2.4 further discusses the moderating influence of social identity as well as potential other moderators on the CLTS intervention effect.

Table 6.1: *Summary of empirical findings of the present thesis*

Intervention effects on latrine construction	
Effect of CLTS compared to control arm	✓
CLTS+RANAS-Public commitment compared to CLTS alone	
CLTS+RANAS-Action planning compared to CLTS alone	
CLTS+RANAS-Public commitment and Action planning compared to CLTS alone	
Variance between communities on latrine construction	✓
CLTS implementation factors predicting community-level latrine coverage	
Time since triggering event	
Community's attendance at meeting	✓
Number of selected natural leaders	✓
Expectation of incentives for latrine construction	✓
Conviction and motivation	
Shame and disgust	
Liking of the facilitators	
Number of follow-up visits of the facilitators	✓
Changes in psychosocial determinants mediating CLTS effects on latrine construction	
Factual (health) knowledge	
Vulnerability	
Severity	
Affective Beliefs	
Instrumental Beliefs	
Descriptive Norms	✓
Injunctive Norms	✓
Action Knowledge	
Self-Efficacy/Maintenance/Recovery Self-Efficacy	✓
Commitment/Personal Norm	✓
Action Planning	✓
Coping Planning	
Social identity moderating CLTS effects on open defecation rate	
Effect of CLTS compared to control arm	✓*
Effect of individual social identity in control arm	
Effect of community's average social identity in control communities	✓
Interaction effect of individual social identity with CLTS	
Interaction effect of community's average social identity with CLTS	✓*

**lower open defecation rates*

6.2. Appraisal of empirical findings for CLTS

The following sections integrate the empirical findings and discuss on the contributions towards an integrated picture of CLTS, in order to ultimately consider the "whole" beyond the "sum of parts" of CLTS. Each section is further illustrated by original comments received from respondents taking part in the randomised controlled trial in Ghana that formed the basis for this thesis' three empirical chapters.[5]

6.2.1. Constructing latrines and stopping open defecation

"We never knew open defecation was bad. But now, we have changed our life styles." Thomas D., 24 years.

Chapter 4 measured the influence of CLTS and combinations of CLTS with theory-based interventions on latrine construction and showed that all interventions were able to increase latrine coverage in intervention communities significantly. Despite the fact that the combination of CLTS with RANAS-based public commitments showed the tendency to lead to higher latrine coverages in communities (see Figure 4.2), no statistical differences were found. This is surprising regarding previous studies that demonstrated highly significant RANAS-based intervention effects as has been discussed in Chapter 4. Several explanations have been indicated, those were among others poor intervention fidelity and potential ceiling effects of CLTS. The latrine count that was used as an outcome measure in Chapter 4 included both completed latrines and those still under construction. Overall, the results presented in Chapter 4 imply that CLTS motivates people start constructing latrines.

Chapter 5 added that CLTS further makes latrine owners to use their latrines, thus to stop open defecation. Figure 6.1 depicts the development of open defecation rates in intervention versus control arms over the time of the trial and shows the decrease of open defecation from 97% to 46% in intervention arms. However, the results of Chapter 4 and 5 show a relevant diversion: at the first follow-up 68% had started latrine construction (Chapter 4), whereas at the second follow-up still 46% reported to practice open defecation (Chapter 5). Those figures reveal a proportion of 22% of latrines that seem to be unused. A closer look in the long-term follow-up data reveal that for those 22% the process of latrine construction was initiated but was not completed one year after CLTS implementation. The reason why people halted the construction process was not investigated to date, but should be included in future analyses. For example by drawing from the diffusion of innovation theory that describes a population that is confronted with an innovation and groups with differing responses to it. Section 6.2.4 further discusses potential reasons why responses to CLTS differ.

[5] Each study participant was given the opportunity to express any thoughts concerning interviews or interventions received. The displayed comments were given in either one of the three panel surveys in Ghana.

The relation of owning a completed latrine and stopping open defecation is a topic widely discussed in CLTS literature. Studies in India reported that households which owned a latrine were not necessarily also using it (Barnard et al., 2013b). In the sample described in this thesis, however, 94% of the households, which owned a completed latrine, also used it. If the remaining 22% unfinished latrines would be completed, open defecation might still further decrease in this sample. However, even without this group of uncompleted and therefore unused latrines, the results of open defecation reduction achieved in this presented sample lie within the wide range of success rates reported for CLTS. For instance in Mali, where 71% of adults stopped open defecation after a CLTS intervention (Pickering et al., 2015) or in Tanzania with 52% (Briceño et al., 2015) or 17% in some part of the research sample in Indonesia (Cameron et al., 2013).

A recent study on long-term effects of CLTS stressed the importance of regarding sustainability of latrines and the consistent use of existing latrines over time (Crocker et al., 2017a). The authors observed an 8% increase of open defecation in the year after intervention implementation for Ethiopia, but persisting intervention effects for Ghana. The results for the sample presented in this thesis point in the same direction as the results of Crocker et al. (2017a) for Ghana: open defecation still decreased in the year after CLTS implementation (see also Figure 6.1). Longer follow-up data could moreover give a clearer picture of this development. Additionally, taking into consideration that CLTS mainly leads to the construction of simple or ventilated pit latrines, the durability of such latrines and the expected future ascent of the "sanitation ladder" must be subject of future research (Crocker et al., 2017a; Venkataramanan et al., 2018).

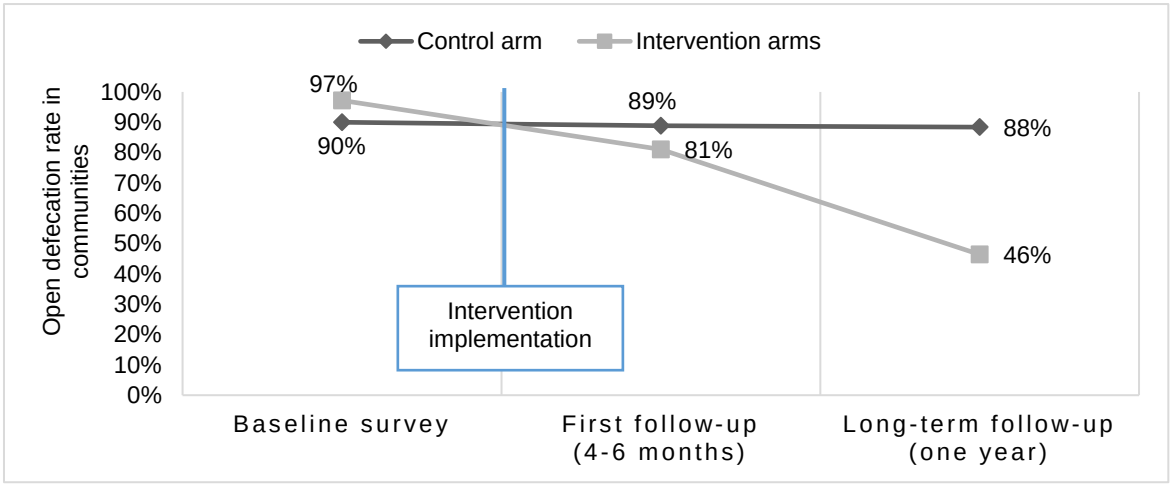


Figure 6.1: *Intervention effects of CLTS on open defecation compared to control arm*

Chapter 4 revealed a great variance in the communities' response to CLTS interventions in any combination (see Figure 4.2). In fact, the mean open defecation rates in intervention communities range from 0-100% with a mean average of 46% (*SD*= 41%). A potential answer to why CLTS is more

successful in some communities compared to others was given in Chapter 5. It was found that CLTS was more successful in stopping open defecation in communities with stronger social identification. This fact and other potential reasons for the differing success of CLTS are discussed in section 6.2.4. Another reason for varying responses to CLTS apart from the social context of the community might lie in the way CLTS was implemented in the various communities. Implications regarding the implementation process of CLTS are discussed in section 6.2.3.

To sum this section, CLTS makes households start latrine construction and stop open defecation. However, latrine coverage does not reach protective thresholds in all target communities. The question of why people stop the construction process of their latrine as well as the question of sustainability of the simple pit latrines remains open.

6.2.2. Towards a successful implementation: what is really needed

"We were told there will be a gift for us after we are done with the construction of our latrines. Now that we have finished constructing our latrines, when will we get our gift?" Hennerey N., 52 years.

As mentioned above, the CLTS Handbook encourages program implementers to adapt the described activities to the needs and conditions of their target communities (Kar & Chambers, 2008). The implementation reality reflects this practice as noted for example in the literature review by Venkataramanan et al. (2018). CLTS most probably has as many faces as implementing organisations (USAID, 2018). To adapt intervention components to local contexts, but maintain the objective of the components the same, is what Hawe et al. (2004) recommend for complex interventions, such as CLTS. This means to keep the objective of establishing a new social norm opposing open defecation, by means of locally adapted intervention activities. The three empirical chapters, presented above, all reported on one of many possible ways of implementing CLTS (and CLTS in combination with theory-based interventions). In this setting, in the Northern Region of Ghana, the implementing NGO (Global Communities) chose to implement CLTS as described in Chapter 4. Within this type of implementation, the most predictive factor was the perception of CLTS participants that the community will receive an incentive for latrine construction. The literature review presented by Venkataramanan et al. (2018) reported on 16% of the documents that estimated the effect of incentives as positive for the success of CLTS implementation, but also points out the ambiguous effect that the provision of incentives might have. As discussed in section 6.2.1, in the studied target population presented here, 22% started latrine construction, but did not complete within one year. Considering the above-presented statement given by one of the respondents, the expectation of a gift in return to constructing latrines may incentivize people to start latrine construction. However, if the incentive is not delivered as expected, the construction process might be stopped. This assumption should be further investigated empirically. Yet, as long as the provision of incentives leads to latrine construction and consistent use, this practice could be a viable strategy as has been discussed in Chapter 3.

The second most predictive factor of CLTS implementation for this sample was the number of follow-up visits by the CLTS facilitators. There is consent on the importance of the post-triggering process, not only in the CLTS Handbook, but also in reports and research on CLTS effectiveness (Cameron & Shah, 2017; Crocker et al., 2016a; Kar & Chambers, 2008; Venkataramanan et al., 2018). Qualitative analysis of responses of the presented sample showed that during follow-up visits, community members mainly experienced facilitators encouraging and reminding them to construct their latrine, but also putting pressure or even threatening non-compliers with police action. Such practices may yield a positive effect in terms of CLTS outcomes: latrine construction. However, long-term effects on the social structure of communities, for example by stigmatization of non-compliers should be the object of future research (Bartram et al., 2012; Dickin et al., 2017; Engel & Susilo, 2014). A thorough investigation of the influence of follow-up visits with a manipulation of their content would help to understand the mechanisms of those visits on CLTS outcomes. In the introductory chapter, the extracted table on BCTs used in CLTS revealed -on basis of the RANAS model- that CLTS includes mainly BCTs that target norm and attitudinal factors to achieve behaviour change outcomes (see Table 1.1). During follow-up visits well-respected facilitators might provide a guidance on what they approve (i.e., injunctive norms) (Crocker et al., 2016a). The analysis of changes in psychosocial determinants achieved by CLTS activities that showed relevance for behaviour change revealed next to norms the importance of changes in the confidence to construct and maintain latrines as well as changes in action planning abilities. Facilitators during follow-up visits may provide support to strengthen both determinants. Though, whether the effect of follow-up visits by facilitators is mediated through changes in injunctive norms, self-efficacy or action planning should be investigated in future research.

Furthermore, villages had higher latrine coverages if more community leaders were selected in the process of CLTS. The superior effect of training natural leaders in addition to the common CLTS canon has been shown in previous research (Crocker et al., 2016a). The authors found that trained natural leaders spent more time on the sanitation improvement process in their communities compared to untrained natural leaders. The way Global Communities implemented CLTS in the target areas of the reported trial also included a training for natural leaders on bacteria transmission pathways and the process of latrine construction. Similar to CLTS facilitators who are not part of the community, natural leaders within the community might show fellow community members their approval of latrines and strengthen the injunctive norm. This in line with the theory of diffusion of innovations, as Crocker et al. (2016a) pointed out in their research on natural leaders. Following this theory, external actors such as the facilitators introduce an innovation and early adopters follow (Nutbeam et al., 2010). The multiplication in the next step happens through “peer-communication and opinion leaders” such as natural leaders (Crocker et al., 2016a). Natural leaders could furthermore take over more responsibility and serve as multipliers. Ideally, natural leaders also realize the BCTs as identified in Chapter 4. E.g., they enhance social support within the community, provide information on sustainable construction

and the actual execution of the construction process, and help to overcome possible barriers and to reframe setbacks as not being due to a lack of capability. In summary, the natural leaders reinforce the messages transmitted by the facilitators, but as insiders of the community and therefore always present.

Another factor explaining latrine coverage was higher attendance at the triggering event. Previous research has shown that participating in CLTS is positively related to constructing latrines (Alemu et al., 2018). Even people not participating, but receiving CLTS-related information via other community members is positively related to latrine construction probability (Harter et al., 2018). Apart from the influence on the injunctive norm, Chapter 4 further revealed the influence of the descriptive norm for the success of CLTS. Higher participation rates might lead to an increased perception of the descriptive norm, such that the norm of constructing latrines rises. The participation rate's moderating influence on the effect of CLTS on changing the descriptive norm might be worth future investigations. Implementers may want to focus on maximizing the number of community members participating in the triggering event, in order to reach better CLTS outcomes.

The above described influential factors- perception of receiving incentives, number of follow-up visits and selected natural leaders, and the attendance at triggering events- all describe the post-triggering process (except attendance rate). Interestingly, the factors rather describing the participants' perception of the triggering event showed no predictive influence for latrine coverage. Neither the feeling of being motivated and convinced by the event, nor the sympathy for the facilitator had a positive influence on latrine coverage. Surprisingly, the same was true for the elicitation of shame and disgust. As has been pointed out in Chapter 3, facilitators might avoid BCTs that elicit strong negative feelings, e.g. they will not carry out the activity featuring food and faeces. The reason might be that such activities are considered as culturally inappropriate (Venkataramanan et al., 2018). The two factors, liking the facilitators and feeling motivated/convinced, showed ceiling effects. Three explanations are possible: either might the chosen items not be sensitive enough for the measurement of these concepts. Alternatively, the facilitators were liked very much and the triggering event was very motivating. Or that telling in an interview that one does not like the facilitator or the event was not convincing is not in accordance with social acceptability, a notion that was pointed out by previous research in developing countries (Contzen et al., 2015a; King & Bruner, 2000). A more objective investigation of the influence of the facilitators' personalities would be desirable. E.g., the investigation could randomly select facilitators for target communities and measure intervention outcomes, or directly observe interaction styles during the triggering event.

Generally, the key finding concerning the implementation process factors is that the follow-up process after the CLTS triggering event is utterly important. The discussed findings confirmed the effectiveness of natural leaders' involvement and the importance of the initial attendance rate at triggering events. It further highlighted the effectiveness of the cautious provision of incentives. The mechanisms of those

implementation factors via psychosocial determinants on behavioural outcomes remain undiscovered and should be set on future research agendas.

6.2.3. Focus on social norms: the obvious secret of CLTS

"We need more education to help change the attitude towards open defecation" Alhaji Y., 37 years.

The following section is structured in two parts: the first one discusses psychosocial determinants that were theoretically expected to be changed at individual level by the implemented interventions. It then compares the theoretically derived determinants to the empirical findings on changes of psychosocial determinants and discusses practical implications. The second part goes beyond the empirical findings and discusses potential improvements of the theoretical considerations on CLTS at community level.

Psychosocial mechanisms of CLTS. In Chapter 1.5, the different CLTS activities were mapped together with the psychosocial determinants they are probably targeting based on the RANAS approach (Mosler & Contzen, 2016). As has been mentioned before, program implementers rarely facilitate all portrayed activities, but choose according to the context of their target community. Global Communities, the implementing NGO, adapted CLTS to the local conditions of the Northern Region of Ghana and selected some of the activities presented in the CLTS Handbook. Activities during triggering events included the drawing of an open defecation map combined with explanations of the faecal-oral transmission route, health expenses calculation, the selection and training of natural leaders, and the development of a community action plan towards becoming ODF. In the post-triggering phase, Global Communities accompanied communities by supporting them in latrine construction.[6]

The first column in Table 6.2 depicts which determinants were expected to be changed through the combination of all intervention activities and their BCTs based on the theoretical background of the RANAS approach (Mosler & Contzen, 2016) (see Table 1.1).

The second column consequently shows determinants whose positive changes successfully mediated CLTS' intervention effects on latrine construction as demonstrated in Chapter 4. Those were descriptive norms, injunctive norms, self-efficacy (combined with maintenance and recovery self-efficacy), action planning and commitment (combined with personal norm)[7]. Section 1.5 further discussed the concept of social identity, which explains that individuals transform the outer pressure

[6] Based on the RANAS approach, three further activities were added: (1) a public commitment together with the provision of stickers for committing to latrine construction and flags for completed latrines, (2) household action planning, and (3) the combination of both. Prior analysis of psychosocial mechanisms showed no differences in changes on psychosocial determinants between the four intervention arms. In the presented results, all four intervention arms were combined.

[7] In order to provide the text in a reader-friendly manner, the scale that comprised personal norm and commitment will only be referred to as "commitment" in the following discussion. The same accounts for the scale including self-efficacy, maintenance and recovery self-efficacy, which will be referred to as "self-efficacy".

resembled by social norms into their own individual pressure (i.e., personal norms), especially if they feel strongly identified with their community (Abrams & Hogg, 1990; Deutsch & Gerard, 1955).

Table 6.2: *Psychosocial mechanisms of CLTS based on theory and empirical findings*

		Empirical results (Chapter 4)	
	Expected changes based on theoretical analysis (RANAS)	Changes mediated intervention effects	Changes influenced behaviour
Factual (health) knowledge	✓		
Vulnerability	✓		✓[1]
Severity	✓		✓
Affective beliefs	✓		
Instrumental beliefs	✓		
Descriptive norms	✓	✓	
Injunctive norms	✓	✓	
Action knowledge	✓		
Self-efficacy (recovery, maintenance)[2]	✓	✓	
Action planning	✓	✓	
Coping planning			✓
Commitment (personal norm)[3]	✓	✓	

Note. Remembering was not considered here. [1] negative changes in vulnerability were positively related to latrine construction [2] Self-efficacy, maintenance and recovery self-efficacy were combined to one scale for this analysis. [3] Personal norm and commitment were combined to one scale for this analysis.

This aspect of transformation of social norms into personal norms is further discussed in Section 6.2.4 of this chapter. In terms of self-efficacy, resembling the confidence in being able to construct and maintain a latrine, even in case of damage, the theoretical assumptions made in the introductory section were confirmed by the empirical findings of Chapter 4. Similar to other health-related behaviours (e.g., handwashing (Contzen & Mosler, 2015; Seimetz et al., 2016) or latrine cleaning (Sonego & Mosler, 2014)), the combined scale of self-efficacy, maintenance and recovery self-efficacy was able to explain CLTS intervention effects on latrine construction. Additionally, the theoretical assumption on the importance of the self-regulation factors for latrine construction was confirmed: CLTS successfully influenced the planning abilities of participants of how and when to construct latrines and this positive change in perceived abilities made people construct latrines.

By comparing the *first and second column*, it is apparent that the empirical findings deviate from the theoretical considerations. Accordingly, CLTS activities would have been expected to achieve additional changes in the following determinants: health knowledge, affective and instrumental beliefs, and action knowledge. The implemented activities, the open defecation map, the discussion of the faecal-oral transmission route and the calculation of health expenses were supposed to target those determinants (see Table 1.1). However, the results of Chapter 4 demonstrate that neither did CLTS achieve changes in those determinants, nor were changes in those determinants beneficial for latrine construction. CLTS implementers should set their focus on those that showed to influence norms, self-efficacy, action planning and commitment. According to Table 1.1, those were the selection of natural leaders, public commitment, forming a community-action plan and the follow-up monitoring.

Finally, the *third column* of Table 6.2 depicts psychosocial determinants that changed without being influenced by CLTS activities and these changes were positively related to latrine construction. The according determinants were vulnerability, severity and coping planning. Based on the theoretical assumptions of CLTS and its respective BCTs, the perception of the personal risk for diarrhoeal diseases (vulnerability) was expected to increase for example by discussing the transmission of faecal bacteria. Contrarily, decreases in risk awareness were positively related with the probability to construct latrines. This might be due to an effect of reverse causality (Conner & Norman, 2005; Contzen & Mosler, 2015): not because vulnerability influenced latrine construction, but rather because people who constructed latrines felt less prone to diarrhoeal diseases (Lilje, 2018). For the determinant severity, i.e., the personal appraisal of the seriousness of getting diarrhoea, increases were positively related to latrine construction. The calculation of health expenses was expected to achieve changes in the perceived severity of getting diarrhoea. However, changes in severity were not achieved through CLTS, but may rather be attributed to other influences, for example to other health-related information campaigns people might have witnessed alongside CLTS activities. For the determinant coping planning, changes were not expected by the implemented BCTs. However, an increase in individual's perceived abilities to cope with arising barriers while constructing latrines were positively related to latrine construction probability. For coping planning abilities, changes might also be explained through the above-mentioned reverse causality effects: people who successfully constructed latrines already have successfully overcome any problems during the latrine construction process. Despite this alternative explanation, BCTs might be stressed and more thoroughly implemented that focus on vulnerability, severity and coping planning, as has been discussed in Chapter 4. For example, coping planning could be strengthened by developing strategies to overcome barriers during construction process, such as lack of materials, by discussing possible solution with community members and natural leaders (BCT 30) (Mosler & Contzen, 2016).

Community-level determinants of CLTS. The previous section presented a picture on the psychosocial mechanisms at individual level of CLTS, the *way*, how CLTS achieves its effects on latrine construction. In more detail, the shift of social norms at first and the strengthening of action planning and self-efficacy that were identified as mediators at individual level. However, despite these individual-level mechanisms, it must be reemphasized that CLTS focuses first on the community level. This stands in contrast to the RANAS model or other behaviour change theories that focus at individual level behaviour change (Abraham & Michie, 2008; Dreibelbis et al., 2013). Sigler et al. (2014) refer to Briscoe and Aboud (2012) and point out that "when the intervention requires the entire community to change […], the activity behind the behaviour change theory may alter". Despite the RANAS model being a theory for individual behaviour change, some of the derived BCTs within the approach implicitly consider the community or in other words are not powerful without drawing on the community's presence (Mosler & Contzen, 2016). Such as the public commitment (BCT 10), which is

only relevant if others are present that observe the committing person or the informing about the approval of important others (BCT 11), such as the facilitator, and the prompting of other's behaviour (BCT 9). Those activities already consider the community level and are unsurprisingly well represented in the CLTS intervention. CLTS further uses the presence of all community members to elicit strong negative feelings of shame. As, per definition, the feeling of shame arises if one's deficits are made public (Bateman & Engel, 2018). Further research is needed and behaviour change models should be developed that, similarly to the RANAS model at individual level, describe behaviour change techniques that target the whole community and target factors that describe the psychosocial mechanisms at community-level.

Similarly, Lapinski and Rimal (2005) distinguish between collective norms that serve as behavioural code and the perceived norm that is the encoding of the collective norm at individual level. The collective norm prescribes a behaviour and the perceived norm leads to the personal enactment of this collective norm. According to the authors, a collective norm emerges "through shared interaction among members of a social group or community, and the manner in which norms emerge is dependent on, among other things, how they are transmitted and socially construed" (Lapinski & Rimal, 2005). An individual's encoding can therefore diverge from the collective norm. Consequently measuring the collective norm is not possible by aggregating the individual's perception. Therefore, the RANAS model remains on an individual level, by asking for the *perceived* descriptive and injunctive norm. In a later revision of their article Rimal and Lapinski (2015) state that collective norms cannot be assessed by aggregating the individual's perception, but by using the actual behaviour of the collective as a proxy for the norm. In terms of CLTS, the campaign, in a first step, creates the new collective norm of latrine construction. In a next step, community members make the collective norm visible by starting the process. The misinterpretation of the collective norm of constructing latrines might therefore not be a problem for CLTS and the individual derives its perceived descriptive and injunctive norm from the collective norm without bigger problems of divergence. Nevertheless, the interpretation of the norm, why one should construct a latrine, might create divergence at least between individuals. The motivation to finish a latrine may depend on the kind of interpretation of the collective norm of latrine construction or becoming open defecation free. One might reason to construct latrines and stop open defecation for health reasons, the other one because he or she expects an incentive and stopping open defecation is not intended. This is where the link to the individual behaviour change theory could be drawn. An assessment of collective norms *and* individual psychosocial factors could improve the understanding of community-driven intervention effects.

In the context of enhancing environmental protective behaviour, a framework was recently presented by Sloot et al. (2017), which explains the engagement of individuals in community initiatives. According to the authors, individuals constantly interact with other initiative's group members, and by this interaction shape their identity, and equally influence the initiative's identity (Sloot et al., 2017).

They postulate that the more individuals identify with the environmental initiative, the more they are likely to engage in the same. Similarly, Chapter 5 demonstrated that CLTS is more effective in stopping open defecation in communities with stronger social identification prior to CLTS implementation. Moreover, not only might the effects of CLTS depend on the level of social identity, but also might the intervention have an influence *on* social identity within communities and this change might be responsible for latrine construction. Therefore, influencing social identification of individuals living in target communities may be regarded as a mechanism of change of CLTS at community level. This correspondents to the Social identity model of collective action (SIMCA) that showed social identity to directly predict the engagement of people in collective actions (Van Zomeren et al., 2008).

Similar to social identity, CLTS might also influence communities' social capital and this increase in trust, cohesion and solidarity (all concepts captured by the term social capital) might provoke latrine construction. As has been pointed out in the introductory section (1.6.2), social capital has been found to successfully drive collective action (Dickin et al., 2017; Ostrom, 2000a) and can consequently be considered as another change mechanism of CLTS at community level. This is in line with the results of a RCT in Indonesia, where CLTS led to increases in social capital in target communities (Cameron et al., 2015). However, this effect was only true for communities that showed higher community participation (one dimension of social capital) prior to CLTS. For communities with lower initial community participation, CLTS provoked negative effects on the community structure: communities experienced a decrease in trust (another dimension of social capital). The results emphasize another important investigation of community-level factors: the long-term or even short-term negative impacts of CLTS on the social structure of communities. The question, whether CLTS does improve or even worsen the community conditions, should be included in future research agendas.

To summarise this section, changes in several psychosocial determinants showed to mediate the effects of CLTS on latrine construction at individual level. Those were positive changes in the social norms, the confidence to construct and maintain latrines, planning abilities and the strength of personal commitment to construct a latrine. Sanitation programs, such as CLTS, should focus on activities to especially target those factors and additionally include activities to foster risk awareness and barrier planning, which showed to be beneficial for behaviour change, but were not addressed by the implemented intervention. Additionally, the attention was drawn to community-level determinants, such as social identity and social capital. Further development of individual behaviour change theories by including community-level determinants and according BCTs was recommended.

6.2.4. For some it works and for some it doesn't: moderators of CLTS' effects

What has been said in the CLTS Handbook that "[communities'] responses [to CLTS] vary widely from the explosive "Match box in a gas station" to the dismal "Damp matchbox" (page 13, (Kar & Chambers, 2008)) has shown to be true for the studied sample in Ghana. Chapter 4 demonstrated that

communities' responses in terms of latrine construction were significantly different. The RANAS model includes three contextual groups (personal, physical and social context) portraying factors that may explain different responses to behaviour change campaigns. Social capital, a factor belonging to the social context, has previously shown to explain differences in communities' responses to CLTS, thus moderating the intervention effect (Cameron et al., 2015). Chapter 5 additionally provided empirical evidence for another social contextual factor, which moderated intervention effects: social identity. Communities with higher social identity than the average community were more successful in stopping open defecation. Social identity theory postulates that strongly identified individuals rather transform the outer pressure that is expressed by social norms into their own personal obligation (Abrams & Hogg, 1990; Deutsch & Gerard, 1955; Hogg & Smith, 2007). This correspondents to the emerging scheme of CLTS achieving its effects by evoking changes in social norms (besides other factors) as has been discussed in the previous section. It was demonstrated that CLTS successfully increased the perception of individuals living in target communities that their fellow community and family members construct latrines and they experienced an increase in the approval of community leaders of latrine construction. Additionally, CLTS increased the commitment and personal norm to construct latrines, what was another mechanism of CLTS' success. Yet, the pathway postulated by the social identity theory of the transformation of social norms into personal norms moderated by social identity was not tested here and remains a task for future research. Interestingly, in control communities the effect of social identity was opposite: the stronger social identification, the higher were open defecation rates. This highlights again the importance of social identification for behaviour change, as strongly identified individuals follow the prevailing norm – open defecation in control communities and latrine construction in intervention communities (Abrams & Hogg, 1990; Cialdini et al., 1990; Schultz et al., 2007). Only in communities with weaker social identification, deviation from norms might be possible as individuals are not as prone to be approved and accepted by other community members (Abrams & Hogg, 1990; Hogg & Smith, 2007). The fact that the moderation effects were only found on community level but not on individual level further indicates social identify being a determinant describing community conditions.

The investigation of group characteristics that explain differing reactions to interventions is an important step towards understanding effect mechanisms (Craig et al., 2018) and in the context of CLTS, the consideration of additional concepts would be aspirational. The following paragraphs introduce further potential concepts that may explain why communities respond differently to CLTS. The first describes the assumed existence of differently characterised groups within target communities, by drawing from the theory of diffusion of innovations (Rogers, 1983, 2010). This is followed by a discussion of the role of leadership for CLTS effectiveness. The third paragraph discusses characteristics of an innovation that may enhance the success of its uptake, in this case the uptake of the idea of constructing latrines.

Different adopter types. The theory of diffusion of innovations describes different groups within a population that are more or less responsive to the introduction of a new idea. Some individuals might be more open to change, whereas others are more hesitant. Those different type of adopters are classified into categories related to the time it takes for them to adopt the innovation (Nutbeam et al., 2010). Innovators are that 2-3% that immediately follow the impulse of an innovation, followed by the 10-15% of early adopters and the early majority of 30-35%. The late majority (30-35%) are more sceptic and only take up an innovation, when the benefits of the innovation are obvious. The last 10-20%, laggards, are the ones that are usually resistant to the uptake of new ideas. The distribution of the different groups is assumed to follow the normal probability distribution (Rogers, 2010). Yet, the investigation of how influential the groups are in a specific setting and related to the idea that is planned to be introduced may help to better react to upcoming difficulties. In terms of CLTS, some groups might vehemently resist to changes in their community, thus object the construction of latrines. The investigation of adopter types within target communities for CLTS might provide substantial information to better plan the implementation process and if necessary respond to special needs of certain adopter types (e.g., specifically involving laggards in the pre-triggering process in order to alleviate their resistance). On the other hand, for the evaluation purpose of a CLTS campaign, investigating characteristics of adopter types may provide an insight in the reasons for non-response. This has recently been done in the context of CLTS by Slekiene and Mosler (2018) in a cross-sectional study in Malawi, where laggards were characterised (amongst other factors) by differences on psychosocial determinants: they felt more vulnerable, showed lower descriptive norms and lower confidence in latrine recovery abilities. Tailoring intervention activities to their special needs would be a next step towards achieving open defecation free communities. In the study sample that formed the basis of his thesis, 22% of the target population were identified in Section 6.2.1 that had started latrine construction, but had not completed within one year after CLTS implementation and thus are still defecating in the open. In order to understand their response to CLTS and reach the total eradication of open defecation, the first step would be to understand what characterises this group in terms of demographics and according to the psychosocial determinants of the RANAS model.

The role of leadership for CLTS. Whether a community has influential leaders that are supportive of CLTS' goals may be utmost beneficial for intervention outcomes. According to the diffusion of innovations theory, change agents initiate the uptake of an innovation and the early adopters follow. As has been pointed out in the context of influential implementation factors of CLTS in section 1.6.2 above, facilitators might be the ones giving the impulse for latrine construction and natural leaders are the multipliers of the innovation within the community (Crocker et al., 2016a).

This is in accordance with several findings reported in CLTS literature. One comes from a literature review on CLTS, where 25% of the included documents stated the "presence of village-level leadership" and another 15% "initiative of natural leaders" as supportive of CLTS success

(Venkataramanan et al., 2018). Accordingly, Crocker et al. (2016a) and Crocker et al. (2016b) showed that a strong local leadership in form of natural leaders was supportive of CLTS outcomes. In the discussion of implementation factors enhancing CLTS' success, the number of selected natural leaders was one influential factor found in the study sample as has been shown in Chapter 3. The emerging scheme of changes in injunctive norms being responsible for latrine construction might indicate the important role natural leaders might play. They might be the ones providing information on the acceptance of latrine construction, or in other words provide legitimacy to the process and act as authorized role models (Crocker et al., 2016a). Accordingly, in a qualitative study on the influence of social capital for CLTS' success, Dickin et al. (2017) found that community leaders were responsible for activating social capital in terms of channelling sanitation-related information to the community members. Finally, the influence of natural leaders or innovators on early and late majority is in line with social identity theory that states that individuals rather follow persuasive messages if delivered by someone of their in-group (Hogg & Smith, 2007).

Characteristics of innovations for successful uptake. The theory of diffusion of innovations further describes characteristics of an introduced innovation that influence its successful uptake. Amongst others, one is the level of how much the innovation fits into the normative system and the economic situation of the community (Nutbeam et al., 2010). In the words of social identity theory, strongly identified individuals consider innovative ideas as more valid if it is concurring with in-group norms (Hogg & Smith, 2007). Thus, stopping open defecation must be something the community already considers as worthwhile or aspirational to take up the innovation of latrines. Whether this is the case for a CLTS target community or not, might be worth investigating before planning a triggering event or otherwise community members might not be open to start the construction process. However, no research has yet addressed this aspect of a potential moderating effect of the level of conformity of stopping open defecation with in-group norms.

Another characteristic of the innovation of a latrine that might strengthen the effects of CLTS on latrine construction is the visibility of the construction process. As has been pointed out already in the context of perceived collective norms in Section 6.2.3, latrine construction is a behaviour that is easily observable by the public - at least in most of the settings CLTS is implemented in. The visibility of other households that construct latrines serve as an easily accessible source of information for the collective norm. According to Lapinski and Rimal (2005) individuals derive their perceived descriptive norm from the collective norm, thus experience an increase in their perception of how many others already started latrine construction. The next step, according to social identity theory is the transformation of this descriptive norm into their own personal norm (Abrams & Hogg, 1990). How much the behaviour is visible in public might be a very powerful moderator of the success of CLTS, and rather underestimated so far. Visibility not only informs about the collective, descriptive and injunctive norms. It also might additionally serve as a reminder of one's own behaviour change, if

intended. The pressure of following the norm is equally higher, if others clearly witness conformity, which is in line with previous research on pro-environmental behaviour, such as littering in public places under observation of by-passers (Cialdini et al., 1990). It is imaginable that as soon as latrines are rather constructed within compounds that are surrounded by walls that protect the inhabitants against views from outsiders, the social norm is not as easily accessible and uptake of latrine construction slower. Again, the role of publicly observable latrines for the success of CLTS has not yet been scientifically analysed and conclusions about the postulated influence are only hypothetical.

The introductory section described potential moderators classified in the personal, physical and social context of the RANAS model and further portrayed social capital and social identity. Both concepts showed to describe fruitful grounds on which CLTS can best yield its effects. Additionally, this section introduced different adopter types according to the diffusion of innovations theory and illustrated potential characteristics of the innovation "latrine" that might foster its uptake. Those were the visibility of latrines and the conformity of the idea of stopping open defecation with community-norms. Further, the existence of strong leadership was discussed as a potential moderator of CLTS' success. Overall, this section showed that CLTS is not a one-fits-all intervention that can be applied without careful consideration of community contexts. As Dickin et al. (2017) pointed out: "communities are not fixed social units but social spaces" that reshape every day. Therefore, this section implies that a thorough planning phase, which includes investigation of relevant factors and knowledge of the target communities with its social structures, is well-invested effort for a better CLTS outcome.

6.3. Integrated behaviour change model of CLTS

The overall aim of this thesis was to shed light on the effectiveness of CLTS on latrine construction and stopping open defecation and on underlying processes involved. It further aimed at improving CLTS. In other words it tried to set parts together for a greater picture of CLTS. Accordingly, the next section summarizes the main findings of this thesis and locates them in an integrated model of CLTS.

The aim of community-based sanitation campaigns, such as CLTS is to elicit individual behaviour change, what cannot be disconnected from the social context individuals live in (Dreibelbis et al., 2013; Mosler & Contzen, 2016; Sigler et al., 2014). A special focus on the community context is necessary when a certain proportion of inhabitants need to change their behaviour for the outcome to be beneficiary for all. The model displayed in Figure 6.2 is based on the RANAS-model, which focuses on individual behaviour change (Mosler & Contzen, 2016). It also draws on the Framework for environmental community initiatives by Sloot et al. (2017) (see also section 6.2.3) and which explains individual's engagement in collective behaviour change initiatives. The integrated model of CLTS extends the RANAS model with the community-level perspective that is graphically represented in the Framework for environmental community initiatives. However, it deviates from the model of Sloot et al. (2017) by focusing on communities instead of environmental initiatives and by including further

community determinants instead of focusing on identity formation in the interaction of individual and community. This integrated model of CLTS shall serve as a graphical representation in which the findings of this thesis can be located and from which implications for future research can be derived. The next paragraphs describe each part of the model, locate the discussed findings of this thesis and point out assumed mechanisms that need further scientific attention.

Behavioural outcomes

The integrated model of CLTS assumes causal pathways from interventional BCTs via individual and community determinants on behavioural outcomes, as postulated by the RANAS model. The aim of community-based interventions is to elicit individual behaviour change. Additionally, the model includes community behaviour. According to Sloot et al. (2017), collective behaviours are "those that involve or affect others". In the context of CLTS, this is for example supporting each other in latrine construction. Besides the causal pathway via changes in determinants, the model includes a direct pathway of intervention on behaviour, because effects on behavioural outcomes are often reported without reporting the intermediate effects and testing effects on outcomes is a first step in evaluating an intervention (Craig et al., 2018).

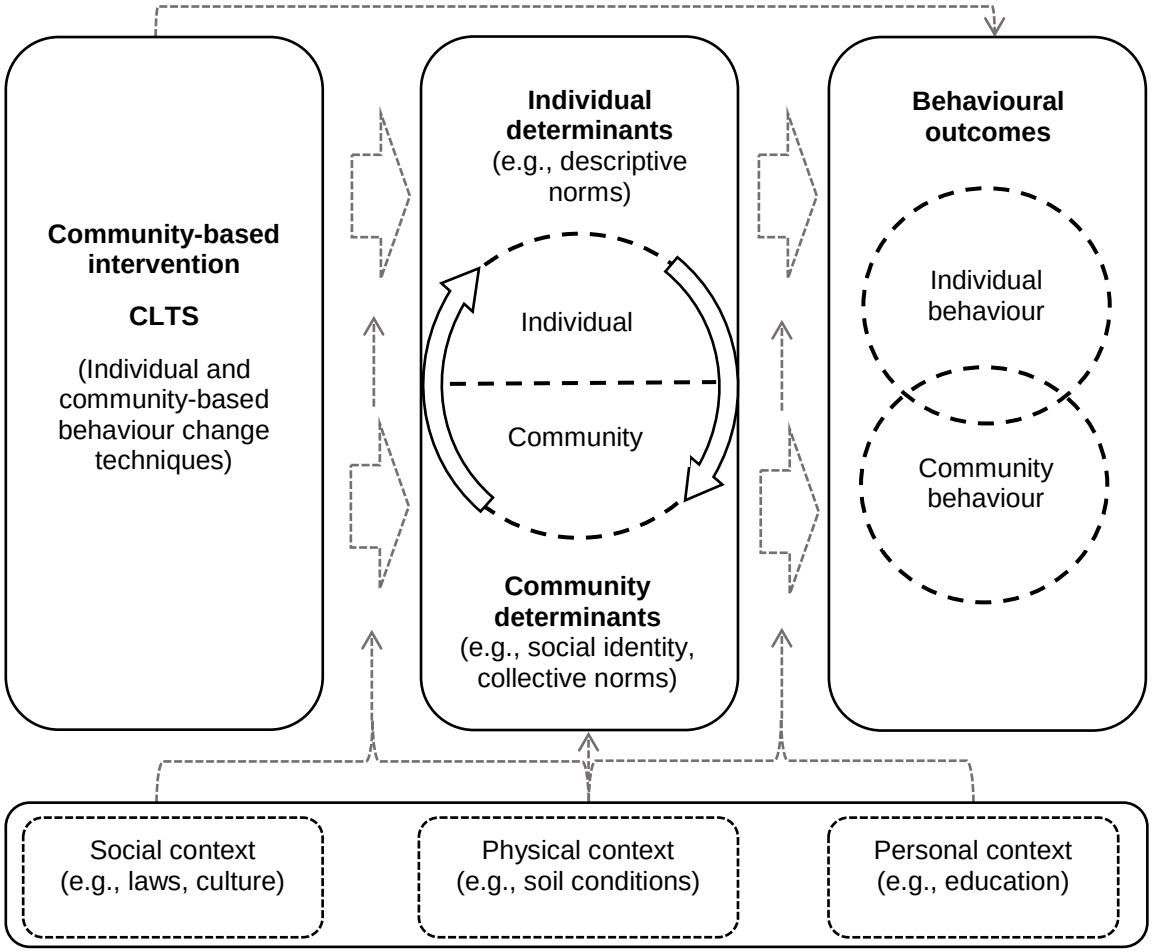


Figure 6.2: *An integrated model of CLTS*

Evidence for this effect of CLTS on latrine construction and open defecation was provided in this thesis. In the presented study sample, owning a completed latrine was a reliable predictor for stopping open defecation. However, a considerable proportion of the sample halted latrine construction and still practised open defecation. The community behaviour (e.g., social support) was not considered in this thesis and should be integrated in future research.

The behaviour change campaign

In line with the RANAS model, the integrated model of CLTS indicates that changing individual behaviour is achieved by the manipulation of psychosocial determinants steering the behaviour. In this thesis, CLTS was demonstrated to influence several psychosocial determinants. More specifically, the manipulation of relevant psychosocial determinants were achieved by involving natural leaders, providing monitoring during follow-up visits, the implementation of public commitments, and community action plans (see discussion of Table 6.2). These causal relations were derived from theoretical considerations only and are yet to be empirically validated, because CLTS activities were not tested individually. Additionally, this thesis demonstrated that campaigns paying attention to the attendance rates during triggering events, providing incentives for latrine construction, focusing on involvement of as many natural leaders and providing as many follow-up visits as possible are expected to be most successful. Thus describing the direct path depicted in the integrated model that leads from intervention to behavioural outcome. Mechanisms of the mentioned components were assumed to mainly be changes in social norms, but were not tested empirically.

The set of BCTs that are combined to one campaign may entail both individual and community- level BCTs. The differentiation of BCTs that target individuals without drawing on the influence of other community members, such as developing individual action plans for latrine construction and BCTs that rely on the community, such as public commitments need further attention.

Individual psychosocial and community determinants

In their framework for environmental community initiatives, Sloot et al. (2017) place the interaction of individuals in the centre of their model and postulate that individuals' and initiative's identities are shaped and reshaped by constant interaction. Similarly, it was postulated that individuals derive their perceived norms from collective norms expressed at community level and the behaviour they observe from other community members (Cialdini, 2007; Lapinski & Rimal, 2005; Rimal & Lapinski, 2015). The investigation of the mutual influence of community and individual determinants was not investigated in this thesis and should be subject of future research.

At individual level, this thesis systematically identified psychosocial determinants steering latrine construction. Changes in five psychosocial determinants were responsible for CLTS effects on latrine construction: positive changes in descriptive and injunctive norms, increases in action planning

abilities and increases in confidence to construct and maintain a latrine as well as strengthened commitment.

At community level, the model includes determinants that are descriptive for each community as possible change mechanisms of CLTS. Additionally, community determinants are part of the social context. In this thesis, evidence was provided demonstrating the moderating influence of social identity on CLTS effects. Thus describing social identity as a contextual factor, according to the RANAS model. Moreover, previous research provided evidence that social capital both moderated and mediated CLTS' intervention effects (Cameron et al., 2015). The same study found negative influences of CLTS on social capital for some communities. Further research is needed to evaluate the impact of CLTS on the social structure of CLTS, for example by including the investigation of influences on social identity and other community determinants.

Contextual influences

Based on the RANAS model, personal, physical and personal contextual factors are integrated in the model that moderate the mechanisms of the intervention via determinants on behaviours. In the context of CLTS, evidence for the influences of all three on CLTS effects were discussed within this thesis. However, so far the postulated pathways of influence as described in the RANAS model have not been investigated. In the context of CLTS, additional investigations of contextual influences would be aspirational to further refine its effects and different responses of communities and individuals as has been portrayed with the concepts of different adopter types, for example.

Implications and future directions

The results presented in this thesis demonstrated the importance of the community for CLTS effects. So far, the community's influence on individual behaviour change was represented in the RANAS model in form of contextual factors and implicitly in form of BCTs relying on the community's presence. This model extends the RANAS model by assuming mutual influences of community and individual determinants. This strongly emphasises the influence of the community on individual behavioural decisions. The importance of social norms, leadership, social identification and other social aspects that emerged as powerful influences on CLTS' effects in this thesis led to the set-up of this model.

The model therefore implies that for planning and evaluating CLTS campaigns, both individual and community perspectives should be included. It follows the recommendations of the MRC and includes portrayed approaches for evaluating complex interventions (Craig et al., 2018). Evaluations of CLTS should first demonstrate the effectiveness of CLTS (i.e., the pathway of intervention on behavioural outcomes) before investigating underlying processes. This should be done by a) evaluating the quality of implementations and level of adaptations and their impact on intervention outcomes, b) investigating

mediators (i.e., changes in individual and community determinants related to behaviour change) and c) moderators (i.e., influence of contextual factors on different pathways) of intervention effects.

The RANAS model demonstrated to be successful in identifying the behavioural determinants of CLTS on individual level and future sanitation campaigns can be designed following the RANAS approach to tackle open defecation in an efficient way. Additionally to the determinants postulated by the RANAS approach, further community level determinants should be considered as potential mechanisms of CLTS. Future studies on CLTS should consider contextual factors of communities and individuals. More studies and theoretical development is needed to define further determinants describing communities in this context as well as their influences on other components in the model. Especially the interaction of individual and community determinants need to be further developed.

6.4. Strengths and limitations

The main strength of this thesis is that it is based on data of a cluster-randomised and controlled trial that was fully powered with 25 clusters and 625 households on average for each of the five compared intervention arms. The sample size of 3216 households allowed for multilevel analysis providing robust results on various behavioural outcomes and accounting for the variance between and within communities. The RCT that forms the basis of this thesis is the first one of this size comparing CLTS to a control arm and combining CLTS with theory-based interventions. Additionally, this thesis provides the first scientific evaluation of CLTS, which includes the investigation of implementation factors enhancing CLTS outcomes, provided evidence on which psychosocial factors explain CLTS intervention effects and further investigated a social contextual moderator. In addition, this thesis represents the first evaluation of CLTS that is based on a theoretical behaviour change model and gives recommendations on the improvement and planning of CLTS interventions based on theory-driven and empirically tested evaluation of underlying psychosocial mechanisms. Accordingly, this thesis has significant practical implications for planning and implementing CLTS, which is the most widely applied sanitation campaign to tackle the problem of open defecation.

Furthermore, this thesis investigated both latrine construction and open defecation as outcome measures. It therefore provides substantial value to the discussion of the effectiveness of CLTS, as latrine construction has been discussed as being no reliable predictor for stopping open defecation. In contrast, the empirical evidence presented here contradicts and adds to this discussion that at least in the case of CLTS implementation within this RCT in Ghana, owning a completed household latrine is strongly related to stopping open defecation.

Nevertheless, this thesis has notable shortcomings. Each empirical chapter discussed limitations individually; however, some overarching issues are specified in more detail in the following sections. Therefore, the generalizability, the study design, sampling, intervention delivery and outcome measures are discussed critically.

Generalizability. As has been pointed out several times throughout this thesis, facilitators of CLTS adapt activities to local conditions of their target communities. This was also done for CLTS implementation in the study area of this project. The results presented in this thesis relate to the specific type of CLTS implementation that was decided on by Global Communities, the implementing NGO in Ghana and account for the specific study population of the Northern Region of Ghana. The same is true for the psychological factors that explained the effects of CLTS in this study as well as for the moderator that was able to explain differences between communities' responses to the intervention. Comparison of those effects in other contexts would be needed to validate the presented findings. Despite this limitation to the specific context of this project, findings emphasize themes of the implementation reality of CLTS that were repeatedly reported, such as the importance of social norms for CLTS' success or the relevance of social contextual preconditions and therefore still provide practical value for future CLTS planning and implementation in other countries or continents.

Study design. The longitudinal cluster-randomised and controlled study design is considered the best option to prevent a potential selection bias (Craig et al., 2018). It allows for drawing likely conclusions on changes in latrine construction and open defecation as well as on psychosocial determinants through CLTS interventions. However, the relation of changes in psychosocial determinants to behavioural outcomes cannot be determined causally. For the analysis of Chapter 4, the mediation analysis of changes in psychosocial determinants on latrine construction, both outcome measures were assessed at the same time-point. To draw robust conclusions on the influence of changes in psychosocial determinants on outcome measures, an experimental manipulation would be necessary. For example in Chapter 4, changes in action planning abilities were positively related to higher probabilities to construct household latrines in this study sample, suggesting that higher planning abilities of when and how to construct a latrine helped people to succeed in construction. Regarding a reverse causality, it would also be conceivable that latrine owners through constructing latrines, increased their planning abilities (for the reverse causality effect, see for example Norman et al. (2005)). Similarly, to psychosocial determinants, the potential influence of social identity was not experimentally manipulated. Communities with strong and weak social identity could be sampled and equally assigned to control and intervention arms to test the intervention effects under different social pre-conditions. The same accounts for Chapter 3, where implementation factors of CLTS were assessed at the same time as latrine coverage in communities, were not experimentally manipulated and interactions were not tested. This should be set on future research agendas (e.g., manipulation of number of follow-up visits). Moreover, an analysis with implementation factors as moderators would better inform on their influences on CLTS' effects on behavioural outcomes (measured at a later time point). Chapter 3 did furthermore not account for the nested structure of our data and therefore might have overestimated statistical significance (Preacher et al., 2010).

In this evaluation, neither single CLTS activities, nor single BCTs of CLTS activities were tested separately on their influences on psychosocial determinants, what was recommended by Sigler et al. (2014). Whether for example, some CLTS activities therefore evoked strong negative feelings of shame or disgust, but other activities compensated it, cannot be concluded by this investigation. Additionally, by combining several BCTs it was not possible to identify the influence of single BCTs on psychosocial determinants individually. Moreover, the RANAS intervention activities were not tested separately of CLTS on their effects on latrine construction. Compared to previous studies on the effects of RANAS-based interventions (for example (Friedrich et al., 2018; Lilje & Mosler, 2018; Sonego & Mosler, 2014), it is surprising that in this study the combinations of CLTS with RANAS-based activities did not yield superior effects. Future research on CLTS could include stand-alone RANAS interventions compared to CLTS alone.

Data was assessed only twice after intervention implementation. The importance of social processes (i.e., relevance of social norms and social identity) point to the direction that more frequent assessments would be needed to capture changes within individuals and communities. Such an approach may for example allow to discover the reasons of why people halted latrine construction more promptly and capture more precisely changes in psychosocial determinants related with this decision.

Intervention delivery. In the presented trial, CLTS and CLTS combined with RANAS-based interventions were implemented in a timely sequence. First CLTS was delivered without additional activities and two months later CLTS and RANAS activities were facilitated in a first pilot phase. Finally, six months after the first community was targeted, the last received their intervention. Because of project size and limited available personnel, a timelier focused implementation was not possible. Due to this time lag, we cannot finally rule out that differences between intervention groups were confounded with other factors, e.g., seasonal influences that might affect conditions enabling or hindering latrine construction. Chapter 4 and 5 however, considered the time elapsed since the triggering event as a confounding variable in sensitivity analyses and Chapter 3 included this variable in the model underlying the main analysis. In none of the analyses however, time was a statistically relevant explaining or confounding factor.

Another limitation relates to intervention fidelity of all four intervention arms. According to Moore et al. (2015) fidelity, adaptations, dose and reach of implemented intervention activities need to be considered. In terms of fidelity, we realized during household interviews that some components of the intervention implementation were not delivered as intended. For example, the sticker for committing publicly to construct latrines was partly handed over in the homestead of participants after the triggering event and not during the community meeting. Concerning adaptation of interventions to community conditions, detailed implementation protocols of CLTS triggering events included some but not all implemented CLTS activities and especially concerning the additional RANAS

interventions, monitoring data was difficult to obtain. As was shown in Chapter 3, the number of follow-up visits was an influential factor for CLTS success. However, the dose of intervention delivery (i.e., number of follow-up visits) was not documented electronically and information was difficult to obtain so that we had to draw from self-reported information of community members, which might be biased because they might not have witnessed or be able to recall all visits. Finally, concerning the reach, a considerable proportion of ca. 20% of the target sample did not receive the planned intervention activities (e.g., sticker, flags or household action plans). A possible explanation is that participation in CLTS events was voluntary and people not present during the meeting were not part of the public commitment activities. Additionally, if community members were not at home at the time of the household visit of facilitators to complete the household action plan, it might be that due to project size, a second visit was not feasible for facilitators.

Data measures. The items used for measuring the psychosocial determinants were pretested in two countries before (Harter et al., 2018) and were derived from previous research projects in this context (Inauen & Mosler, 2014; Tumwebaze & Mosler, 2014; Tumwebaze et al., 2014), however, it was the first time they were used in Ghana. The questionnaire was not tested prior to the surveys on reliability and validity. To ensure consistent translation to the seven local languages that were used for interviews, we translated and re-translated items and uniform terminologies were agreed in each language for every item. Were possible, psychosocial concepts were assessed by several items for validation. However, some concepts were only measured on single-item scales and consequently constitutes a limitation of Chapter 4. Social identity was assessed through several items that were combined to one single scale, however, reliability was low (Cronbach's alpha= .64).

The assessment of outcome behaviours was gained through self-report instead of objective measurements. The use of self-reported data is prone to biases, because participants may tend to over-report the "good" behaviour, thus act socially desirable (Johnson & Van de Vijver, 2003; King & Bruner, 2000). The reason might be the expectation of any benefits if responses are given as expected (Contzen et al., 2015a) as can be assumed by the statement reported in one of the sections above. While the existence of a functional latrine was validated through spot-check observations after interviews, the actual use of the latrine was only assessed by proxy measures. Those included the observation of availability of anal cleansing material, traces of faeces or urine, observing the path leading to latrines and evaluating whether it appeared used. Accordance of self-reported use and the validation by our staff was high (97%).

6.5. Conclusions and practical implications

Provide access to safe sanitation services is one of the Sustainable Development Goals set by the United Nations. Despite great efforts in achieving this goal, a considerable number of 892 million people still practise open defecation, which entails important health threats for public health. This thesis aimed at

testing the effectiveness and understanding the mechanisms of Community-Led Total Sanitation (CLTS) on the eradication of open defecation. It further aimed at providing possible recommendations for the improvement of this community-based behaviour change intervention. Therefore, psychosocial determinants, contextual factors and intervention components were investigated in a cluster-randomised and controlled trial in Ghana.

CLTS was implemented and tested against a combination of CLTS with population-tailored and evidence-based interventions following the RANAS model of behaviour change. CLTS in any combination was successful in motivating people to construct latrines and stop open defecation. Significant differences in the effectiveness on latrine construction between the different intervention arms were not found. Results on the relevance of different intervention components revealed the importance of follow-up visits and the involvement of natural community leaders in the monitoring process for the success of CLTS. Moreover, results demonstrated the great potential lying in the careful provision of incentives for latrine construction in communities. Additionally, it was shown that the more community inhabitants participate in the CLTS events, the higher are community latrine coverages. The RANAS model successfully identified psychosocial mechanisms that were responsible for latrine construction. The most relevant determinants showed to be social norms including the perception of others constructing latrines and important people approving of it, the confidence in being able to construct and maintain a latrine, the planning abilities concerning latrine construction, and commitment to do it. To further improve CLTS, BCTs that influence risk awareness and the confidence in coping with arising problems during latrine construction is recommended. Moreover, the results demonstrated that CLTS is more successful in community contexts where individuals strongly identify with each other. The findings led to the preliminary development of an integrated model of CLTS that accounts for the emerged influence of the community on individual's behaviour change.

Several practical implications of this thesis' findings concerning the implementation and improvement of CLTS for stopping open defecation are noteworthy. Implementing partners should consider the social conditions they are dealing with in target communities. The importance of leadership emerged as well as the consideration of different potential adopter types that need to be involved in the process to ameliorate potential resistance. The role of natural leaders and facilitators in evoking a shift in social norms towards stopping open defecation was demonstrated. Thus, program implementers should train both facilitators and natural leaders in order to create awareness for their important role for the success of CLTS. Additionally, several factors described an enabling social environment for CLTS to succeed. Practitioners should pay attention to them and either strengthen them if needed or draw on their potential. One of these determinants was the social identification of individuals within communities, meaning the value individuals give to their belonging to the community. Another was social capital, including concepts of trust, cohesion and the presence of networks, such as health clubs. Making sure that latrine construction is visible within the community and that stopping open defecation is conform

with the community's norms was discussed as other potential factors enabling successful implementation.

For the campaign itself, several recommendations can be derived. Neither did knowledge on the transmission of diarrhoeal diseases play a role for CLTS success nor the elicitation of strong negative feelings. The same accounts for the perceptions of costs and benefits related to latrine construction. The very common open defecation mapping, calculation of medical costs for diarrhoeal diseases, and discussion of the faecal-oral transmission route did not influence CLTS outcomes. This implies that the focus should rather be set on CLTS activities that strengthen social norms and confidence in and planning of latrine construction and the strengthening of commitment. Most probably, those were support during follow-up visits, involvement of natural leaders, public commitments as well as the development of community action plans. To achieve higher latrine coverages, the attendance rates at the triggering event should be high and facilitators might consider providing incentives for latrine construction.

I hope that the presented findings and materials encourage both practitioners and researchers working in the development context to implement community-based interventions by considering both individual and community-level perspectives. I hope that by providing results on different aspects of CLTS and combining it in an overall picture of CLTS in form of an integrated model, this thesis will help to improve the intervention's outcomes and over all improve the sanitation situation in communities.

7. References

Abraham, C., & Michie, S. (2008). A taxonomy of behavior change techniques used in interventions. *Health Psychology*, 27, 379-387.

Abrams, D., & Hogg, M.A. (1990). Social identification, self-categorization and social influence. *European review of social psychology*, 1, 195-228.

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, 50, 179-211.

Alemu, F., Kumie, A., Medhin, G., & Gasana, J. (2018). The role of psychological factors in predicting latrine ownership and consistent latrine use in rural Ethiopia: a cross-sectional study. *BMC public health*, 18, 229.

Alemu, F., Kumie, A., Medhin, G., Gebre, T., & Godfrey, P. (2017). A socio-ecological analysis of barriers to the adoption, sustainablity and consistent use of sanitation facilities in rural Ethiopia. *BMC public health*, 17, 706.

Arnold, B.F. (2009). Methods to Study Intervention Sustainability Using Pre-existing, Community Interventions: Examples from the Water, Sanitation and Hygiene Sector. UC Berkeley.

Atkinson, A. (2017). Monitoring global poverty: Report of the commission on global poverty. *World Bank, Washington*.

Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology*, 27, 14-25.

Bamberg, S., Rees, J., & Seebauer, S. (2015). Collective climate action: Determinants of participation intention in community-based pro-environmental initiatives. *Journal of Environmental Psychology*, 43, 155-165.

Barnard, S., Barnard, P., Routray, F., Majorin, R., Peletz, S., Boisson, A., et al. (2013a). Impact of Indian Total Sanitation Campaign on Latrine Coverage and Use: A Cross-Sectional Study in Orissa Three Years following Programme Implementation. *PLoS ONE*, 8, e71438.

Barnard, S., Routray, P., Majorin, F., Peletz, R., Boisson, S., Sinha, A., et al. (2013b). Impact of Indian Total Sanitation Campaign on latrine coverage and use: a cross-sectional study in Orissa three years following programme implementation. *PLoS ONE*, 8, e71438.

Bartram, J., Charles, K., Evans, B., O'Hanlon, L., & Pedley, S. (2012). Commentary on community-led total sanitation and human rights: should the right to community-wide health be won at the cost of individual rights? *J Water Health*, 10, 499-503.

Bateman, M., & Engel, S. (2018). To shame or not to shame—that is the sanitation question. *Development Policy Review*, 36, 155-173.

Bodin, Ö., & Crona, B.I. (2008). Management of Natural Resources at the Community Level: Exploring the Role of Social Capital and Leadership in a Rural Fishing Community. *World Development*, 36, 2763-2779.

Bongartz, P., Vernon, N., & Fox, J. (2016). *Sustainable sanitation for all: experiences, challenges and innovations*: Practical Action.

Briceño, B., Coville, A., & Martinez, S. (2015). Promoting handwashing and sanitation: evidence from a large-scale randomized trial in rural Tanzania. Policy Research working paper ; no. WPS 7164 ; Impact Evaluation series. Washington, DC: World Bank Group. .

Briscoe, C., & Aboud, F. (2012). Behaviour change communication targeting four health behaviours in developing countries: a review of change techniques. *Social Science & Medicine*, 75, 612-621.

Cameron, J.E. (2004). A three-factor model of social identity. *Self and identity*, 3, 239-262.

Cameron, L., Olivia, S., & Shah, M. (2015). Initial Conditions Matter: Social Capital and Participatory Development. *Available at SSRN: https://ssrn.com/abstract=2704614 or http://dx.doi.org/10.2139/ssrn.2704614*.

Cameron, L., & Shah, M. (2017). Scaling up sanitation: Evidence from an rct in indonesia. *IZA Discussion Paper No. 10619. Available at SSRN: https://ssrn.com/abstract=2940609*.

Cameron, L., Shah, M., & Olivia, S. (2013). *Impact evaluation of a large-scale rural sanitation project in Indonesia*: The World Bank.

Cavill, S., Chambers, R., & Vernon, N. (2015). Sustainability and CLTS: Taking Stock. In B.I. Frontiers of CLTS: Innovations and Insights Issue 4 (Ed.), Frontiers of CLTS: Innovations and Insights 4.

Chambers, R. (2006). Participatory mapping and geographic information systems: whose map? Who is empowered and who disempowered? Who gains and who loses? *The Electronic Journal of Information Systems in Developing Countries*, 25.

Chambers, R. (2013). *Ideas for development*: Routledge.

Cialdini, R.B. (2007). Descriptive social norms as underappreciated sources of social control. *Psychometrika*, 72, 263.

Cialdini, R.B., Reno, R.R., & Kallgren, C.A. (1990). A focus theory of normative conduct: recycling the concept of norms to reduce littering in public places. *Journal of Personality and social Psychology*, 58, 1015.

Clasen, T., Boisson, S., Routray, P., Torondel, B., Bell, M., Cumming, O., et al. (2014). Effectiveness of a rural sanitation programme on diarrhoea, soil-transmitted helminth infection, and child malnutrition in Odisha, India: a cluster-randomised trial. *The Lancet Global Health*, 2, e645-e653.

Coffey, D., Geruso, M., & Spears, D. (2017). Sanitation, Disease Externalities and Anaemia: Evidence From Nepal. *The Economic Journal*.

Cohen, J. (1992). A power primer. *Psychological bulletin*, 112, 155.

Coleman, J.S. (1988). Social capital in the creation of human capital. *American journal of sociology*, 94, S95-S120.

Conner, M., & Norman, P. (2005). *Predicting health behaviour*: McGraw-Hill Education (UK).

Contzen, N., De Pasquale, S., & Mosler, H.-J. (2015a). Over-reporting in handwashing self-reports: Potential explanatory factors and alternative measurements. *PLoS ONE*, 10, e0136445.

Contzen, N., & Inauen, J. (2015). Social-cognitive factors mediating intervention effects on handwashing: a longitudinal study. *Journal of behavioral medicine*, 38, 956-969.

Contzen, N., & Marks, S.J. (2018). Increasing the regular use of safe water kiosk through collective psychological ownership: A mediation analysis. *Journal of Environmental Psychology*, 57, 45-52.

Contzen, N., Meili, I.H., & Mosler, H.-J. (2015b). Changing handwashing behaviour in southern Ethiopia: A longitudinal study on infrastructural and commitment interventions. *Social Science & Medicine,* 124, 103-114.

Contzen, N., & Mosler, H.-J. (2013). Impact of different promotional channels on handwashing behaviour in an emergency context: Haiti post-earthquake public health promotions and cholera response. *Journal of Public Health,* 21, 559-573.

Contzen, N., & Mosler, H.-J. (2015). Identifying the psychological determinants of handwashing: results from two cross-sectional questionnaire studies in Haiti and Ethiopia. *American journal of infection control,* 43, 826-832.

Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., & Petticrew, M. (2018). Developing and evaluating complex interventions: Medical Research Council. Advance online publication.

Crocker, J., Abodoo, E., Asamani, D., Domapielle, W., Gyapong, B., & Bartram, J. (2016a). Impact Evaluation of Training Natural Leaders during a Community-Led Total Sanitation Intervention: A Cluster-Randomized Field Trial in Ghana. *Environmental science & technology,* 50, 8867-8875.

Crocker, J., Geremew, A., Atalie, F., Yetie, M., & Bartram, J. (2016b). Teachers and sanitation promotion: an assessment of community-led total sanitation in Ethiopia. *Environmental science & technology*.

Crocker, J., Saywell, D., & Bartram, J. (2017a). Sustainability of community-led total sanitation outcomes: Evidence from Ethiopia and Ghana. *International Journal of Hygiene and Environmental Health,* 220, 551-557.

Crocker, J., Saywell, D., Shields, K.F., Kolsky, P., & Bartram, J. (2017b). The true costs of participatory sanitation: Evidence from community-led total sanitation studies in Ghana and Ethiopia. *Science of The Total Environment,* 601-602, 1075-1083.

De Cremer, D., Hoogervorst, N., & Desmet, P. (2012). Procedural justice and sanctions in social dilemmas: The moderating effects of group feedback and identification. *Journal of applied social psychology,* 42, 1675-1693.

Deutsch, M., & Gerard, H.B. (1955). A study of normative and informational social influences upon individual judgment. *The Journal of Abnormal and Social Psychology,* 51, 629-636.

Dickin, S., Bisung, E., & Savadogo, K. (2017). Sanitation and the commons: The role of collective action in sanitation use. *Geoforum,* 86, 118-126.

Dickinson, K., Patil, S., Pattanayak, S., Poulos, C., & Yang, J.-H. (2015). Nature's call: impacts of sanitation choices in Orissa, India. *Economic Development and Cultural Change,* 64, 1-29.

Dickinson, K., & Pattanayak, S.K. (2009). Open sky latrines: Do social interactions influence decisions to use toilets. Working paper.

Dooley, T., Maule, L., & Gnilo, M. (2016). Using social norms theory to strengthen CATS impact and sustainability. *Sustainable Sanitation for All: Experiences, challenges, and innovations,* 299.

Dreibelbis, R., Winch, P.J., Leontsini, E., Hulland, K.R., Ram, P.K., Unicomb, L., et al. (2013). The integrated behavioural model for water, sanitation, and hygiene: a systematic review of behavioural models and a framework for designing and evaluating behaviour change interventions in infrastructure-restricted settings. *BMC public health,* 13, 1015.

Elbers, C., Godfrey, S., Gunning, J.W., van der Velden, M., & Vigh, M. (2012). Effectiveness of Large Scale Water and Sanitation Interventions: the One Million Initiative in Mozambique. *Tinbergen*

Institute Discussion Paper 12-069/2. Available at SSRN: https://ssrn.com/abstract=2111138 or http://dx.doi.org/10.2139/ssrn.2111138.

Engel, S., & Susilo, A. (2014). Shaming and Sanitation in Indonesia: A Return to Colonial Public Health Practices? *Development and Change*, 45, 157-178.

Esrey, S.A. (1996). Water, Waste, and Well-Being: A Multicountry Study. *American Journal of Epidemiology*, 143, 608-623.

Ferguson, C.J. (2009). An effect size primer: A guide for clinicians and researchers. *Professional Psychology: Research and Practice*, 40, 532.

Fewtrell, L., Kaufmann, R.B., Kay, D., Enanoria, W., Haller, L., & Colford Jr, J.M. (2005). Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. *The Lancet Infectious Diseases*, 5, 42-52.

Field, A. (2009). *Discovering statistics using SPSS*: Sage publications.

Floyd, D.L., Prentice-Dunn, S., & Rogers, R.W. (2000). A meta-analysis of research on protection motivation theory. *Journal of applied social psychology*, 30, 407-429.

Friedrich, M.N., Kappler, A., & Mosler, H.-J. (2018). Enhancing handwashing frequency and technique of primary caregivers in Harare, Zimbabwe: A cluster-randomized controlled trial using behavioral and microbial outcomes. *Social Science & Medicine*, 196, 66-76.

Fuller, J.A., & Eisenberg, J.N.S. (2016). Herd Protection from Drinking Water, Sanitation, and Hygiene Interventions. *The American journal of tropical medicine and hygiene*, 95, 1201-1210.

Galvin, M. (2015). Talking shit: is Community-Led Total Sanitation a radical and revolutionary approach to sanitation? *Wiley Interdisciplinary Reviews: Water*, 2, 9-20.

Garn, J.V., Sclar, G.D., Freeman, M.C., Penakalapati, G., Alexander, K.T., Brooks, P., et al. (2016). The impact of sanitation interventions on latrine coverage and latrine use: A systematic review and meta-analysis. *International Journal of Hygiene and Environmental Health*.

GBD 2015 Risk Factors Collaborators (2016). Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *The Lancet*, 388, 1659-1724.

Geruso, M., & Spears, D. (2018). Neighborhood sanitation and infant mortality. *American Economic Journal: Applied Economics*, 10, 125-162.

Grootaert, C., & Van Bastelaer, T. (2002). *Understanding and measuring social capital: A multi-disciplinary tool for practitioners*.

Hamaker, E.L. (2012). Why researchers should think "within-person": A paradigmatic rationale. *Handbook of research methods for studying daily life*, 43-61.

Hammer, J., & Spears, D. (2016). Village sanitation and child health: effects and external validity in a randomized field experiment in rural India. *Journal of Health Economics*, 48, 135-148.

Harter, M., Mosch, S., & Mosler, H.-J. (2018). How does Community-Led Total Sanitation (CLTS) affect latrine ownership? A quantitative case study from Mozambique. *BMC public health*, 18, 387.

Hawe, P., Shiell, A., & Riley, T. (2004). Complex interventions: how "out of control" can a randomised controlled trial be? *BMJ*, 328.

Hayes, A.F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*: Guilford Press.

Hoffmeyer-Zlotnik, J.H. (2003). New sampling designs and the quality of data. *Developments in applied statistics. Ljubljana: FDV Methodoloski zvezki*, 205-217.

Hogg, M.A., & Reid, S.A. (2006). Social Identity, Self-Categorization, and the Communication of Group Norms. *Communication Theory*, 16, 7-30.

Hogg, M.A., & Smith, J.R. (2007). Attitudes in social context: A social identity perspective. *European review of social psychology*, 18, 89-131.

Homish, G.G., Edwards, E.P., Eiden, R.D., & Leonard, K.E. (2010). Analyzing Family Data: A GEE Approach for Substance Use Researchers. *Addictive behaviors*, 35, 558-563.

House, S., Cavill, S. and Ferron, S. (2017). Equality and non-discrimination (EQND) in sanitation programmes at scale. In B. IDS (Ed.), Frontiers of CLTS: Innovations and Insights 10.

Inauen, J., & Mosler, H.J. (2014). Developing and testing theory-based and evidence-based interventions to promote switching to arsenic-safe wells in Bangladesh. *J Health Psychol*, 19, 1483-1498.

Jans, L., Bouman, T., & Fielding, K. (2018). A Part of the Energy\" In Crowd\": Changing People's Energy Behavior via Group-Based Approaches. *IEEE Power and Energy Magazine*, 16, 35-41.

Jans, L., Leach, C.W., Garcia, R.L., & Postmes, T. (2015). The development of group influence on in-group identification: A multilevel approach. *Group Processes & Intergroup Relations*, 18, 190-209.

Jenkins, M., Freeman, M., & Routray, P. (2014). Measuring the Safety of Excreta Disposal Behavior in India with the New Safe San Index: Reliability, Validity and Utility. *International Journal of Environmental Research and Public Health*, 11, 8319-8346.

Jenkins, M.W., & Curtis, V. (2005). Achieving the 'good life': why some people want latrines in rural Benin. *Social Science & Medicine*, 61, 2446-2459.

JMP. (2015). The new JMP ladder for sanitation. https://washdata.org/monitoring/sanitation.

Johnson, T.P., & Van de Vijver, F.J. (2003). Social desirability in cross-cultural research. *Cross-cultural survey methods*, 325, 195-204.

Julian, T.R. (2016). Environmental transmission of diarrheal pathogens in low and middle income countries. *Environmental Science: Processes & Impacts*, 18, 944-955.

Jung, Y.T., Hum, R.J., Lou, W., & Cheng, Y.-L. (2017a). Effects of neighbourhood and household sanitation conditions on diarrhea morbidity: Systematic review and meta-analysis. *PLoS ONE*, 12, e0173808.

Jung, Y.T., Lou, W., & Cheng, Y.L. (2017b). Exposure-response relationship of neighbourhood sanitation and children's diarrhea. *Tropical Medicine & International Health*.

Kar, K. (2003). Subsidy or self-respect?: participatory total community sanitation in Bangladesh.

Kar, K. (2012). Why not Basics for All? Scopes and Challenges of Community-led Total Sanitation. *IDS Bulletin*, 43, 93-96.

Kar, K., & Chambers, R. (2008). Handbook on community-led total sanitation.

King, M.F., & Bruner, G.C. (2000). Social desirability bias: A neglected aspect of validity testing. *Psychology & Marketing*, 17, 79-103.

Koo, T.K., & Li, M.Y. (2016). A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *Journal of chiropractic medicine*, 15, 155-163.

Kramer, R.M. (2006). Social identity and social capital: The collective self at work. *International Public Management Journal*, 9, 25-45.

Kumar, N., & Shukla, J. (2008). Doing CLTS in a Countrywide Programme Context in India: Public Good, Private Good? *L. Mehta and S. Movik Shit Matters: The Potential of Community-Led Total Sanitation London, Practical Action*.

Landrigan, P.J., Fuller, R., Acosta, N.J., Adeyi, O., Arnold, R., Baldé, A.B., et al. (2017). The Lancet Commission on pollution and health. *The Lancet*.

Lapinski, M.K., & Rimal, R.N. (2005). An Explication of Social Norms. *Communication Theory*, 15, 127-147.

Lawrence, J.J., Yeboah-Antwi, K., Biemba, G., Ram, P.K., Osbert, N., Sabin, L.L., et al. (2016). Beliefs, Behaviors, and Perceptions of Community-Led Total Sanitation and Their Relation to Improved Sanitation in Rural Zambia. *The American journal of tropical medicine and hygiene*, 94, 553-562.

Lilje, J. (2018). Providing and Evaluating Evidence-based Water, Sanitation and Hygiene Behavioral Interventions for Prevention and Control of Cholera. Universität Zürich.

Lilje, J., & Mosler, H.-J. (2018). Effects of a behavior change campaign on household drinking water disinfection in the Lake Chad basin using the RANAS approach. *Science of The Total Environment*, 619-620, 1599-1607.

Mara, D., Lane, J., Scott, B., & Trouba, D. (2010). Sanitation and health. *PLoS Med*, 7, e1000363.

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., et al. (2013). The Behavior Change Technique Taxonomy (v1) of 93 Hierarchically Clustered Techniques: Building an International Consensus for the Reporting of Behavior Change Interventions. *Annals of Behavioral Medicine*, 46, 81-95.

Monney, I., Baffoe-Kyeremeh, A., & Amissah-Reynolds, P.K. (2015). Accelerating rural sanitation coverage in Ghana: what are the speed bumps impeding progress? *Journal of Water Sanitation and Hygiene for Development*, 5, 531-543.

Moore, G.F., Audrey, S., Barker, M., Bond, L., Bonell, C., Hardeman, W., et al. (2015). Process evaluation of complex interventions: Medical Research Council guidance. *BMJ*, 350, h1258.

Mosler, H.-J. (2012). A systematic approach to behavior change interventions for the water and sanitation sector in developing countries: a conceptual model, a review, and a guideline. *International journal of environmental health research*, 22, 431-449.

Mosler, H.-J., & Contzen, N. (2016). Systematic behavior change in water, sanitation and hygiene. A practical guide using the RANAS a pproach. Version 1.1. Switzerland: Dübendorf, Switzerland: Eawag.

Mosler, H.-J., Mosch, S., & Harter, M. (2018). Is Community-Led Total Sanitation connected to the rebuilding of latrines? Quantitative evidence from Mozambique. *PLoS ONE*, 13, e0197483.

Neighbors, C., LaBrie, J.W., Hummer, J.F., Lewis, M.A., Lee, C.M., Desai, S., et al. (2010). Group Identification as a Moderator of the Relationship Between Perceived Social Norms and Alcohol Consumption. *Psychology of addictive behaviors : journal of the Society of Psychologists in Addictive Behaviors,* 24, 522-528.

Nielsen, L., Riddle, M., King, J.W., Aklin, W.M., Chen, W., Clark, D., et al. (2017). The NIH Science of Behavior Change Program: Transforming the science through a focus on mechanisms of change. *Behaviour research and therapy*.

Norman, P., Boer, H., & Seydel, E.R. (2005). Protection motivation theory. *Predicting health behaviour,* 81, 126.

Novotný, J., Hasman, J., & Lepič, M. (2018). Contextual factors and motivations affecting rural community sanitation in low- and middle-income countries: A systematic review. *International Journal of Hygiene and Environmental Health,* 221, 121-133.

Novotný, J., Kolomazníková, J., & Humňalová, H. (2017). The role of perceived social norms in rural sanitation: an explorative study from infrastructure-restricted settings of South Ethiopia. *International Journal of Environmental Research and Public Health,* 14, 794.

Nutbeam, D., Harris, E., & Wise, W. (2010). *Theory in a nutshell: a practical guide to health promotion theories*: McGraw-Hill.

Oakley, A., Strange, V., Bonell, C., Allen, E., & Stephenson, J. (2006). Process evaluation in randomised controlled trials of complex interventions. *BMJ,* 332, 413-416.

Ostrom, E. (2000a). Collective action and the evolution of social norms. *Journal of economic perspectives,* 14, 137-158.

Ostrom, E. (2000b). Social capital: a fad or a fundamental concept. *Social capital: A multifaceted perspective,* 172, 195-198.

Patil, S.R., Arnold, B.F., Salvatore, A.L., Briceno, B., Ganguly, S., Colford Jr, J.M., et al. (2014). The effect of India's total sanitation campaign on defecation behaviors and child health in rural Madhya Pradesh: a cluster randomized controlled trial. *PLoS ONE*.

Pattanayak, S.K., Yang, J.-C., Dickinson, K.L., Poulos, C., Patil, S.R., Mallick, R.K., et al. (2009). Shame or subsidy revisited: social mobilization for sanitation in Orissa, India. *Bulletin of the World Health Organization,* 87, 580-587.

Pickering, A.J., Djebbari, H., Lopez, C., Coulibaly, M., & Alzua, M.L. (2015). Effect of a community-led sanitation intervention on child diarrhoea and child growth in rural Mali: a cluster-randomised controlled trial. *The Lancet Global Health,* 3, e701-e711.

Pickering, A.J., Julian, T.R., Marks, S.J., Mattioli, M.C., Boehm, A.B., Schwab, K.J., et al. (2012). Fecal contamination and diarrheal pathogens on surfaces and in soils among Tanzanian households with and without improved sanitation. *Environmental science & technology,* 46, 5736-5743.

Preacher, K.J., Zyphur, M.J., & Zhang, Z. (2010). A general multilevel SEM framework for assessing multilevel mediation. *Psychological methods,* 15, 209.

Prestwich, A., Conner, M., & Kenworthy, J. (2017). *Health behavior change: Theories, methods and interventions*: Routledge.

Pretty, J. (2003). Social capital and the collective management of resources. *Science,* 302, 1912-1914.

Prüss-Üstün, A., & Corvalán, C. (2006). Preventing disease through healthy environments. *Geneva: World Health Organization*.

Prüss-Üstün, A., Wolf, J., Corvalán, C.F., Bos, R., & Neira, M.P. (2016). Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks.

Prüss-Ustün, A., Bartram, J., Clasen, T., Colford, J.M., Cumming, O., Curtis, V., et al. (2014). Burden of disease from inadequate water, sanitation and hygiene in low-and middle-income settings: a retrospective analysis of data from 145 countries. *Tropical Medicine & International Health,* 19, 894-905.

Putnam, R.D. (1993). The prosperous community. *The american prospect,* 4, 35-42.

Rabe-Hesketh, S., Skrondal, A., & Pickles, A. (2004). Generalized multilevel structural equation modeling. *Psychometrika,* 69, 167-190.

Rains, S.A., & Turner, M.M. (2007). Psychological reactance and persuasive health communication: A test and extension of the intertwined model. *Human Communication Research,* 33, 241-269.

Reynolds, K.J., Subašić, E., & Tindall, K. (2015). The problem of behaviour change: From social norms to an ingroup focus. *Social and Personality Psychology Compass,* 9, 45-56.

Rimal, R.N., & Lapinski, M.K. (2015). A re-explication of social norms, ten years later. *Communication Theory,* 25, 393-409.

Rinker, D.V., & Neighbors, C. (2014). Do different types of social identity moderate the association between perceived descriptive norms and drinking among college students? *Addictive behaviors,* 39, 1297-1303.

Robinson, A. (2016). Final Evaluation: Pan African CLTS program 2010-2015. Plan Netherlands.

Rogers, E.M. (1983). *Diffusion of innovations*: The Free Press.

Rogers, E.M. (2010). *Diffusion of innovations*: Simon and Schuster.

Root, G.P. (2001). Sanitation, community environments, and childhood diarrhoea in rural Zimbabwe. *Journal of Health, Population and Nutrition*, 73-82.

Rosenstock, I.M. (1974). Historical origins of the health belief model. *Health education monographs,* 2, 328-335.

Schultz, P.W., Nolan, J.M., Cialdini, R.B., Goldstein, N.J., & Griskevicius, V. (2007). The Constructive, Destructive, and Reconstructive Power of Social Norms. *Psychological Science,* 18, 429-434.

Schwarzer, R. (2008). Modeling health behavior change: How to predict and modify the adoption and maintenance of health behaviors. *Applied Psychology,* 57, 1-29.

Schwarzer, R., Lippke, S., & Ziegelmann, J.P. (2008). Health action process approach: A research agenda at the Freie Universität Berlin to examine and promote health behavior change. *Zeitschrift für Gesundheitspsychologie,* 16, 157-160.

Seimetz, E., Boyayo, A.-M., & Mosler, H.-J. (2016). The influence of contextual and psychosocial factors on handwashing. *The American journal of tropical medicine and hygiene,* 94, 1407-1417.

Shakya, H.B., Christakis, N.A., & Fowler, J.H. (2015). Social network predictors of latrine ownership. *Social Science & Medicine,* 125, 129-138.

Sigler, R., Mahmoudi, L., & Graham, J.P. (2014). Analysis of behavioral change techniques in community-led total sanitation programs. *Health promotion international*.

Slekiene, J., & Mosler, H.-J. (2018). Characterizing the Last Latrine Nonowners in Rural Malawi. *The American journal of tropical medicine and hygiene,* 98, 295-299.

Sloot, D., Jans, L., & Steg, L. (2017). *The potential of environmental community initiatives–a social psychological perspective*: Bundesamt für Naturschutz.

Solon, P. (2010). The Human Right to Water and Sanitation. *Speech delivered at the UN General Assembly, New York,* 28.

Sonego, I.L., & Mosler, H.-J. (2014). Why are some latrines cleaner than others? Determining the factors of habitual cleaning behaviour and latrine cleanliness in rural Burundi. *Journal of Water Sanitation and Hygiene for Development,* 4, 257-267.

Spears, D. (2012). Effects of rural sanitation on infant mortality and human capital: evidence from India's Total Sanitation Campaign. *Washington, DC: Princeton University*.

Spears, D. (2013). How much international variation in child height can sanitation explain?

Spears, D., & Lamba, S. (2015). Effects of early-life exposure to sanitation on childhood cognitive skills: Evidence from India's Total Sanitation Campaign. *Journal of Human Resources*.

Spybrook, J., Bloom, H., Congdon, R., Hill, C., Martinez, A., Raudenbush, S., et al. (2011). Optimal design plus empirical evidence: Documentation for the "Optimal Design" software. *William T. Grant Foundation. Retrieved on November,* 5, 2012.

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology,* 29, 309-317.

Stocker, A., & Mosler, H.J. (2015). Contextual and sociopsychological factors in predicting habitual cleaning of water storage containers in rural Benin. *Water Resources Research,* 51, 2000-2008.

Tajfel, H. (1978). Differentiation between social groups: Studies in the social psychology of intergroup relations. In H. Tajfel (Ed.), Differentiation between social groups: Studies in the social psychology of intergroup relations. pp. xv, 474-xv, 474). Oxford, England: Academic Press.

Tajfel, H., & Forgas, J.P. (2000). Social categorization: Cognitions, values and groups. *Stereotypes and prejudice: Essential readings.* pp. 49-63). New York, NY, US: Psychology Press.

Tajfel, H., & Turner, J.C. (1979). An integrative theory of intergroup conflict. *The social psychology of intergroup relations,* 33, 74.

Terry, D.J., Hogg, M.A., & White, K.M. (1999). The theory of planned behaviour: self-identity, social identity and group norms. *British journal of social psychology,* 38, 225-244.

Trusty, J., Thompson, B., & Petrocelli, J.V. (2004). Practical guide for reporting effect size in quantitative research in the Journal of Counseling & Development. *Journal of Counseling & Development,* 82, 107-110.

Tumwebaze, I.K., & Mosler, H.-J. (2014). Shared toilet users' collective cleaning and determinant factors in Kampala slums, Uganda. *BMC public health,* 14, 1260.

Tumwebaze, I.K., & Mosler, H.-J. (2015). Effectiveness of group discussions and commitment in improving cleaning behaviour of shared sanitation users in Kampala, Uganda slums. *Social Science & Medicine,* 147, 72-79.

Tumwebaze, I.K., Niwagaba, C.B., Günther, I., & Mosler, H.-J. (2014). Determinants of households' cleaning intention for shared toilets: Case of 50 slums in Kampala, Uganda. *Habitat International,* 41, 108-113.

Turner, J.C., Hogg, M.A., Oakes, P.J., Reicher, S.D., & Wetherell, M.S. (1987). *Rediscovering the social group: A self-categorization theory*: Basil Blackwell.

Tyndale-Biscoe, P., Bond, M., & Kidd, R. (2013). ODF Sustainability Study. *FH Designs. Australia: PLAN International*, 1-181.

USAID. (2018). An Examination of CLTS's Contributions toward Universal Sanitation. USAID Water, Sanitation, and Hygiene Partnerships and Sustainability (WASHPaLS) Project. Washington, DC.

van Vugt, M. (2001). Community Identification Moderating the Impact of Financial Incentives in a Natural Social Dilemma: Water Conservation. *Personality and social psychology bulletin,* 27, 1440-1449.

Van Zomeren, M., Postmes, T., & Spears, R. (2008). Toward an integrative social identity model of collective action: A quantitative research synthesis of three socio-psychological perspectives. *Psychological bulletin,* 134, 504.

Venkataramanan, V., Crocker, J., Karon, A., & Bartram, J. (2018). Community-led total sanitation: a mixed-methods systematic review of evidence and its quality. *Environmental health perspectives,* 26001, 1.

Vyas, S., Kov, P., Smets, S., & Spears, D. (2016). Disease externalities and net nutrition: evidence from changes in sanitation and child height in Cambodia, 2005–2010. *Economics & Human Biology,* 23, 235-245.

Waddington, H., Snilstveit, B., White, H., & Fewtrell, L. (2009). Water, sanitation and hygiene interventions to combat childhood diarrhoea in developing countries. *New Delhi: International Initiative for Impact Evaluation*.

White, K.M., Smith, J.R., Terry, D.J., Greenslade, J.H., & McKimmie, B.M. (2009). Social influence in the theory of planned behaviour: The role of descriptive, injunctive, and in-group norms. *British journal of social psychology,* 48, 135-158.

WHO, & UNICEF (2017). *Progress on drinking water, sanitation and hygiene: 2017 update and SDG baselines*: World Health Organization.

Wolf, J., Hunter, P.R., Freeman, M.C., Cumming, O., Clasen, T., Bartram, J., et al. (2018). Impact of drinking water, sanitation and handwashing with soap on childhood diarrhoeal disease: updated meta-analysis and meta-regression. *Tropical Medicine & International Health,* 23, 508-525.

Wolf, J., Prüss-Ustün, A., Cumming, O., Bartram, J., Bonjour, S., Cairncross, S., et al. (2014). Systematic review: assessing the impact of drinking water and sanitation on diarrhoeal disease in low-and middle-income settings: systematic review and meta-regression. *Tropical Medicine & International Health,* 19, 928-942.

World Health Organization (WHO) (2018). Guidelines on sanitation and health.

Zeger, S.L., & Liang, K.-Y. (1986). Longitudinal data analysis for discrete and continuous outcomes. *Biometrics*, 121-130.

Zeger, S.L., Liang, K.-Y., & Albert, P.S. (1988). Models for longitudinal data: a generalized estimating equation approach. *Biometrics*, 1049-1060.

Annex I: Questionnaire of the first follow-up survey

Welcome to the Eawag questionnaire about latrine use. Please swipe forward to continue.

Hello, my name is _____ and I work for Eawag, the Swiss Institute for Water Research. We lead an investigation on behavior related to sanitation and household hygiene. In addition to your community, this survey takes place in other villages of Bole and Sawla-Tuna-Kalba districts.

The purpose of this investigation is to know about your daily hygiene practices and sanitation situation to improve thereafter, the hygiene and sanitation situation in Ghana
Maybe you remember that we have been here with you last year. This is the second interview we are doing with you if you agree. This will help us understand what has changed during the last year.
The participation contains no risk for you. We will question you about what you think and do during your day.
All information is anonymous and confidential. Participation in the survey is voluntary.

Interview Information

Date of the Interview		
Enter Household ID from your list here.		
Please re-enter the household's ID as confirmation.		
Is this household available for this interview?	0	*No*
	1	*Yes, consent is given*

PLEASE USE THE OTHER FORM FOR RESOPONDENTS THAT ARE NOT AVAILABLE.

Basic information		
Name of the Interviewer		
Name of the district	1	*Bole*
	2	*Sawla-Tuna-Kalba*
Name of the community (Bole)		
Name of the community (Sawla)		
What is your name?		
How do people in the community call you? (Nickname or family name)		
What is the name of the household's head?		
In which section of your community do you live?		
Please provide us with your phone number		
This mentioned number belongs to…	1	*the household of the respondent*
	2	*relatives, neighbours, friends*
	3	*no phone number*
Relationship to the head of household: The head of the household is my …	1	*wife*
	2	*husband*
	3	*daughter*
	4	*mother*
	5	*sister*
	6	*son*
	7	*father*
	8	*brother*
	9	*grandson*

			10	*granddaughter*
			11	*I am the head of the household*
		Please choose gender.	1	*female*
			2	*male*
		What is your age?		
		What is your religion you are currently practicing?	1	*Islam*
			2	*Christian*
			5	*Traditional religion*
			6	*non-believer*
		Which is/are the language/s that you speak most fluently?	1	*Wale*
			2	*Dagaare*
			3	*Gonja*
			4	*Mo*
			5	*Twi*
			6	*Berefo*
			7	*Vagla*
			8	*English*
			9	*Lobi*
			10	*Safalba*
			11	*Ewe*
DHS Index	*household*	What is your MAIN water source?	2	*piped into compound/plot*
			3	*public tap*
			4	*tubewell or borehole*
			5	*protected well*
			6	*unprotected well*
			7	*spring*
			8	*river, stream, pond, lake or dam*
			9	*rainwater for drinking*
			10	*tanker truck or cart*
			11	*bottled drinking water*
			12	*sachet water*

Latrine use and open defecation frequency

We would like to know some things about your personal defecation habit and that of the members of your household. Please try to answer each question as precisely as you can. The following questions refer to situations, when you are in your community.

Safe San Index	*Personal Morning*	On how many of the last 7 'mornings' did you defecate in the open? (e.g. field, bush, roadside, side of canal, back of house, etc.)	*1=no days (0) to 5=every day(7)*
	Midday	On how many of the last 7 middays did you defecate in the open?	*1=no days (0) to 5=every day(7)*

	Evening/ Night	On how many of the last 7 evenings or nights did you defecate in the open?		*1=no days (0) to 5=every day(7)*
Safe San Index	*Personal Morning*	On how many of the last 7 'mornings' did you use the latrine?		*1=no days (0) to 5=every day(7)*
Self composed	*Personal Midday*	On how many of the last 7 middays did you use the latrine?		*1=no days (0) to 5=every day(7)*
Self composed	*Personal Evening/ Night*	On how many of the last 7 evenings or nights did you use the latrine?		*1=no days (0) to 5=every day(7)*
		INTERVIEWER: Please decide in reference to the questions above if the respondent does:	1	*use the latrine exclusively*
			2	*defecate in the open exclusively*
			3	*use the latrine AND does open defecation*
Latrine Use	*Field work*	When you work on the farm, do you use a latrine or do you defecate in the open?	1	*latrine*
			2	*open defecation*
			3	*no need for defecation*
			4	*no farming*
Safe San Index	*Women OD*	On how many of the last 7 days did adult women of your household defecate in the open?		*1=no days (0) to 5=every day(7)*
Safe San Index	*Men OD*	On how many of the last 7 days did adult men of your household defecate in the open?		*1=no days (0) to 5=every day(7)*
Safe San Index	*Children OD*	On how many of the last 7 days did children (above 5) of your household defecate in the open?		*1=no days (0) to 5=every day(7)*
Safe San Index	*Women LU*	On how many of the last 7 days did adult women of your household use the latrine?		*1=no days (0) to 5=every day(7)*
Safe San Index	*Men LU*	On how many of the last 7 days did adult men of your household use the latrine?		*1=no days (0) to 5=every day(7)*
Safe San Index	*Children LU*	On how many of the last 7 days did children (5-17) of your household use the latrine?		*1=no days (0) to 5=every day(7)*
Safe San Index	*Babies faeces*	Where do you usually dispose of your baby's/babies' (0-4) faeces?	0	*No babies*
			2	*Into latrine/toilet*
			3	*Into rubbish/ garbage can*
			4	*We don't do anything with the feaces*
			5	*Cover with soil*
			6	*somewhere in the bush/ field*

Decision question		Does your household have an own latrine?	1	*1=No, 2=Yes (finished or under construction)*
		Are you currently using your own latrine?	1	*1=No, 2=Yes*
		Why not?	1	*it is damaged*
			2	*it is still under construction*
			3	*I don't like using it*
general information	*Sanitation Situation*	Is the latrine you are using private or is it shared?	1	*only we use it*
			2	*private, but other households use it as well*
			3	*latrine belongs to another household but we use it as well*
			4	*public latrine*
		How many households are sharing the latrine?		
Psychosocial factors (RANAS) concerning latrine construction				
Attitudes	*Instrumental B.*	How far is it from your house to the latrine you are currently using?		*1=not at all far to 5=very far*
general information	*Sanitation Situation*	How accessible is the latrine for the use by children?		*1=not at all accessible to 5=very accessible*
		How easy is the use of the latrine for aged people?		*1=not at all easy to 5=very easy*
		How safe is it for women to use the latrine?		*1=not at all safe to 5=very safe*
		How accessible is the latrine by night?		*1=not at all accessible to 5=very accessible*
		How accessible is it when it is raining?		*1=not at all accessible to 5=very accessible*
In the following section we would like to ask you some questions about the construction of latrines.				
general information	*Defecation practice*	Did you use a latrine before and then had to stop using it for some reason (for example because it collapsed)?		*1=No, 2=Yes*
		Why did you have to stop using it?	1	*full pit*
			2	*latrine damaged*
			3	*latrine collapsed*
			4	*flooding*
			5	*dirt*
			6	*relocated to different area*
Self-Regulation	*Action Knowledge*	Can you tell us for each of the following features if this is neccessary for a hygienically safe latrine?		
		paint the walls		*0=I dont know, 1=No, 2=Yes*
		vent pipe		*0=I dont know, 1=No, 2=Yes*

		have seperate latrines for men and women		*0=I dont know, 1=No, 2=Yes*
		decking without holes (other than the drop hole)		*0=I dont know, 1=No, 2=Yes*
		weeding around the latrine		*0=I dont know, 1=No, 2=Yes*
		dark inside the latrine		*0=I dont know, 1=No, 2=Yes*
General Information	*Reasons*	What are the reasons that you didn't construct your own latrine?	1	*Lack of funds*
			2	*No construction knowledge*
			3	*Tough soil conditions*
			4	*Open defecation is preferred*
			5	*Lack of strenght/ illness*
			6	*no time*
Intention		Do you plan to construct your own latrine?		*1=No, 2=Yes*
Self-Regulation	*Action Plan LC*	Do you have a plan when you will construct a latrine?		*1=No, 2=Yes*
		Please specify when you will start (in months)!		
		Do you have a plan how you will gather the materials for the latrine construction?		*1=No, 2=Yes*
		Please specify how!	1	*Collect materials from the sorrounding*
			2	*Produce the materials by myself*
			3	*Ask friends for materials*
			4	*get vent pipe from global communities/ NGO*
			5	*get cement from global communities/NGO*
			6	*buy the materials*
		Do you have a plan how you will get the money to buy the materials for the latrine construction?		*1=No, 2=Yes*
		Please specify how!	1	*Sale of farm products*
			2	*Sale of animals*
			3	*Financial support by relatives*
		Do you have a plan who will help you to construct the latrine?		*1=No, 2=Yes*
		Please specify who!	1	*Relatives (e.g. children, brother, etc.)*

			2 *Friends* 3 *Hire labourer* 4 *Respondent mentions specific person* 5 *Government/ NGO*
Intention		How strongly do you intend to construct your own latrine?	*1=no high intention at all to 5=very high intention*
Willingness to pay		What would be the maximum amount you would be willing to pay for the construction of your own latrine in Cedi (GHS)?	

INTERVIEWER: Remember, that the respondent does NOT have a latrine. Please introduce the following section with: "Imagine you would have constructed your own latrine. What do you think about the following questions?"

Attitudes	*Affective B.*	How proud are you of your own latrine?	*1=not at all proud to 5=very proud*
		Do you think you are more respected by your community because you have an own latrine?	*1=not at all more respected to 5=very much more respected*
		If you construct a latrine, do you think you are more vulnerable for envy?	*1=not at all vulnerable to 5=very vulnerable*
Attitudes	*Instrumental B.*	Do you think that constructing your own latrine is expensive?	*1=not at all expensive to 5=very expensive*
		How difficult is it to find the money to construct your own latrine?	*1=not at all difficult to 5=very difficult*
		How difficult is it to find the time and effort to construct your own latrine?	*1=not at all difficult to 5=very difficult*
Social Support		Who in your household made the final decision to construct your own latrine?	*1=Head of household to 5=Landlord*
Norms	*Descriptive N.*	How many of your relatives within your community constructed an own latrine?	*1=(Almost) nobody (0%) to 5=(Almost) all of them (100%)*
		How many members of your community constructed an own latrine?	*1=(Almost) nobody (0%) to 5=(Almost) all of them (100%)*
Norms	*Injunctive N.*	How much do people who are important to you (e.g. family, parents, friends) approve that you construct a latrine?	*1=approve not at all to 5=approve very much*
		People who are leaders in the community (e.g. opinion leader, Chief of village, etc.) how much do they promote that you construct an own latrine?	*1=not at all to 5=very much*
Norms	*Personal N.*	Do you feel a personal obligation to construct an own latrine?	
Abilities	*Self-Efficacy*	How confident are you that you can construct a latrine even if this is difficult (e.g. gathering the materials)?	*1=not at all confident to 5=very confident*
Abilities	*Maintenance Self-Efficacy*	How confident are you that you could finish the construction of a latrine even if problems arise (e.g. you run out of money)?	*1=not at all confident to 5=very confident*

Abilities	*Recovery Self-Efficacy*	Imagine that the latrine got damaged. How confident are you that you will be able to repair the latrine again?		*1=not at all confident to 5=very confident*
Self-Regulation	*Coping Planning*	Do you have a plan how you can construct a latrine if you are running out of materials?	1	*Collect local materials*
			8	*buy materials somewhere*
			2	*Go for local dealers*
			3	*Borrow material from others*
			4	*Ask relatives for help*
			5	*Sell animals/ farm products to buy more materials*
			6	*Produce the materials by myself*
			7	*No plan*
	Commitment	Do you feel committed to construct a latrine?		*1=not at all committed to 5=very committed*

CLTS

We have learned that there were some interventions in your area (implemented by Global Communities). We would like to take the opportunity to learn more about it.

General Info	*CLTS meeting*	In your village, has there been a meeting or an NGO member who talked about open defecation, latrine use or latrine construction since we have been here for the last interview?		*1=No, 2=Yes*
CLTS	*CLTS meeting participation*	Did you participate?		*1=No, 2=Yes*
		Did someone else of your household participate?		*1=No, 2=Yes*
	CLTS Activities	Thinking about the group meeting for the latrine construction program in your community : Which activities do you remember? (OPEN QUESTION: DON'T READ THE ANSWER CATEGORIES)	1	*details on latrine construction methods*
			2	*how to dig a pit*
			3	*community mapping*
			4	*fecal-oral transmission route (fingers, flies, pigs, chicken)*
			6	*leaders were selected*
			7	*bottle of water and dirt*
			9	*handwashing was discussed*
			10	*tippy-tap construction*
			11	*shit calculation*
			12	*medical calculation*
			13	*by-laws for people not constructing latrines*

		14	*distribution of stickers*
		15	*distribution of flags*
		16	*pledging to construct a latrine (to get a sticker)*
		17	*leaders promised to construct a latrine*
		18	*other people promised to construct a latrine*
		19	*promise to get a water pump if we construct latrines*
		20	*cannot remember any of the activities*
Feelings CLTS meeting	How much did you like this community meeting?		*1=not at all to 5=very much*
	To what extent did the activities in the meeting convince you to build a latrine?		*1=convinced me not at all to 5=convinced me very much*
	How much did the meeting make you feel disgusted?		*1=not at all disgusted to 5=very disgusted*
	How much did the meeting make you feel ashamed?		*1=not at all ashamed to 5=very ashamed*
	How much did the meeting make you feel motivated?		*1=not at all motivated to 5=very motivated*
	How much did the meeting make you feel angry?		*1=not at all angry to 5=very angry*
Atmosphere after CLTS	Since the community meeting, do people have more disagreements/quarrels than before? How much?		*1=not at all more fighting to 5=very much more fighting*
Facilitator	How much did you like the facilitators of this meeting?		*1=not at all to 5=very much*
Social Pressure	How much did you feel under pressure to construct a latrine after the meeting?		*1=not at all under pressure to 5=very much under pressure*
	How much did other members of the community urge you to construct a latrine?		*1=not at all to 5=very much*
Incentive	Were you promised something during this meeting in return for constructing a latrine?		*1=No, 2=Yes*
	What were you promised?	1	*bore hole*
		2	*certificate*
		3	*signpost*
		4	*sticker*
	Who promised it?	1	*Government*
		2	*NGO*

		3	*people from the community*
		4	*Family*
	CLTS Follow-Up		
	Did the facilitator(s) come back to your community in the following weeks of the meeting?	1	*I dont remember*
		2	*no*
		3	*yes*
	How many times?	1	*he/she was here only once*
		2	*came back 2 times*
		3	*3 times*
		4	*4 times*
		5	*more than 4 times*
	What did they do and tell you in their following visits?	1	*explained decking*
		2	*explained digging*
		3	*explained superstructure*
		4	*forced people to build latrines*
		5	*spoke to natural leaders*
		6	*supported us*
		7	*said open defecation is bad*

Action Planning intervention check

	Please show this Action Plan to your respondent.		
Action Planning	Did you receive this kind of paper after the community meeting?		*1=No, 2=Yes*
Understanding	Can you please show it to me?	1	*Yes*
		2	*No, I lost the paper*
		3	*No, The children took it away*
		4	*No, I forgot where it is*
	Who received the Action Plan?	1	*respondent him/herself*
		2	*husband of the respondent*
		3	*son or daughter of the respondent*
		4	*brother / uncle of the respondent*
	INTERVIEWER: Who will answer the questions about the Action Plan?	1	*respondent him/herself*
		2	*husband of the respondent*

		3	*son or daughter of the respondent*
		4	*brother / uncle of the respondent*
	In your own words, can you explain what that paper means?	1	*individual steps for latrine construction for me*
		2	*deadline for my latrine construction*
		3	*control of my progress*
		5	*responsible person was identified*
		4	*I do not know/ forgot*
		6	*I should construct a latrine*
	What do these suns and moons mean?	1	*sun stands for day*
		2	*moon stands for month*
		3	*this is the timeline for my own latrine construction*
		4	*I don't know*
Follow-Up Action Plan	How many times did the facilitator come to your house?	0	*no one was here*
		1	*he/she was here only once*
		6	*came back once*
		2	*came back 2 times*
		3	*came back 3 times*
		4	*came back 4 times*
		5	*came back more than 4 times*
	What did the facilitator do when she/he came back after she/he discussed this paper with you?	1	*asked to construct the latrine*
		2	*discussed the steps of the action plan with me*
		3	*changed the timeline on the action plan*
		4	*crossed out suns and moons on the action plan*
Facilitator	How strongly did the facilitator urge you to construct a latrine?		*1=not at all to 5=very much*
	How much did you like it when the facilitators came into your household?		*1=liked it not at all to 5=liked it very much*

	Observation	How is the action plan filled in?	1	*name of the respondent is filled in*
			2	*start and end date are filled in*
			3	*moons and suns are entered in the timeline*
			4	*responsible person is marked*
			5	*signs of monitoring are visible (crossed suns/ moons)*
			6	*thumbprint/signature is given*
			7	*nothing is filled in*
		Is the action plan placed visibly outside of the house?		*1=No, 2=Yes*
		Where is it kept?	1	*On another place but visible*
			2	*Kept away (folder, under mattress, etc.)*
Public commitment intervention check				
		Show this sticker to the respondent		
Public commitment	*Sticker*	Did you receive this kind of sticker from your facilitator?		*1=No, 2=Yes*
		Why not?	1	*I was not at the community meeting*
			2	*There were not enough stickers*
			3	*I do not know*
			4	*Only community leaders received one*
		Can you please show it to me?	1	*No, I lost the sticker*
			2	*No, The children took it away*
			3	*Yes*
		Where did you receive the sticker?	1	*At the community meeting*
			2	*at home after the community meeting*
			3	*I do not remember*
	Observation	The sticker is placed visibly at the wall outside the house.	1	*Yes*
			2	*No, it is inside the house*
			3	*No, it is placed outside but not visible*
		In your own words, what does this sticker mean?	1	*I promised to construct a latrine*
			2	*I own a latrine*

		3	*I am part of the community program*
		4	*I do not know*
	How much do you like this sticker?		*1=not at all to 5=very much*
	How proud do you feel to have this sticker?		*1=not at all to 5=very much*
	How many members of your community have such a sticker?		*1=(Almost) nobody (0%) to 5=(Almost) all of them (100%)*
	How often did it happen that other members of the community reminded you that you should construct a latrine because you have a sticker?		*1=never to 5=very often*
Flag	Did you receive a flag from your facilitator?		*1=No, 2=Yes*
	Can you please show it to me?	1	*No, I lost the flag*
		2	*No,the children took it away*
		3	*Yes*
	In your own words, what does this flag mean?	1	*I promised to construct a latrine*
		2	*I own a latrine*
		3	*I am part of the community program*
		4	*I do not know*
	How much do you like this flag?		*1=not at all to 5=very much*
	How proud do you feel to have this flag?		*1=not at all to 5=very much*
	How many members of your community have such a flag?		*1=(Almost) nobody (0%) to 5=(Almost) all of them (100%)*
Observation	Where is the flag kept?	1	*it is visibly fixed at the toilet*
		2	*it is fixed at the toilet but not visible*
		3	*it is inside the toilet*
		4	*it is fixed at the house*
	Subsidies		
Subsidies	Did you receive any subsidy for the construction of your own latrine within the last year?		*1=No, 2=Yes*
	What kind of subsidy did you receive?	1	*Financial*
		2	*Materials*
		3	*Labour*
	Who provided you with this subsidy?	1	*Government*
		2	*NGO*
		3	*people from the community*
		4	*Family*
Social Context			

Social Dilemma	*Locus of control*	How many members of your community would have to stop defecating in the open to prevent ALL members of the community from getting diarrhea?	*1=(Almost) nobody (0%) to 5=(Almost) all of them (100%)*
		How many members of your community should stop defecating openly that you would also stop it?	*1=(Almost) nobody (0%) to 5=(Almost) all of them (100%)*
	Talking frequency	How often do you talk with other members of your community about the sanitation situation of your village?	*1=never to 5=very often*
	Trust	How much do you trust that if people say they don't defecate openly they are really using their latrine?	*1=not at all to 5=very*
Social Cohesion	*Neighbourhood Cohesion*	Given the opportunity, I would like to move out of this community.	*1=agree not at all to 5=agree very much*
	Neighbourhood Cohesion	I would be willing to work together with others on something to improve my community.	*1=agree not at all to 5=agree very much*
Social Capital	*trust and solidarity*	If a community project does not directly benefit me but has benefits for many others in the community, I would still contribute to the project.	*1=agree not at all to 5=agree very much*
Social Identity	*Centrality*	I often think about the fact that I am a member of this community.	*1=agree not at all to 5=agree very much*
Social Capital	*trust and solidarity*	Most people who live in this community can be trusted.	*1=agree not at all to 5=agree very much*
Social Identity	*In-group Affects*	In general, I'm glad to be a member of this community.	*1=agree not at all to 5=agree very much*
Social Capital	*Empowerment and political action*	I have the freedom to make important decisions that change my life.	*1=agree not at all to 5=agree very much*
Social Identity	*Ingroup Ties*	I have a lot in common with other members of the community.	*1=agree not at all to 5=agree very much*
	Ingroup Ties	I find it difficult to form a bond with other members of the community.	*1=agree not at all to 5=agree very much*
	Centrality	In general, being a member of this community is an important part of my identity.	*1=agree not at all to 5=agree very much*
	In-group Affects	I don't feel good about being a member of this community.	*1=agree not at all to 5=agree very much*
Social Capital	*Collective Action and Cooperation*	How likely is it that people who do not participate in the community efforts towards an open defecation free environment will be criticized or sanctioned?	*1=not at all likely to 5=very likely*
		How many people in this community contribute towards the common goal of an open defecation free community?	*1=(Almost) nobody (0%) to 5=(Almost) all of them (100%)*
		If there is a sanitation problem in this community, how likely is it that people will cooperate to try to solve the problem?	*1=not at all likely to 5=very likely*
	social cohesion and inclusion	In the last month, how many times have you met with other members of the community to have an informal chat?	*1=never to 5=very often*
Health status			

		The next section asks for general information on your current health status, your family's disease history, and your personal thoughts on the topic of diarrhea.	
Health Situation		How satisfied are you with the current health situation of your family?	*1=not at all satisfied to 5=very satisfied*
		How frequently does your youngest child under five suffer from diarrhea?	*1=never to 5=several times a month*
		How frequently do you suffer from diarrhea?	*1=never to 5=several times a month*
Risk Perception		Generally, how high do you think is the chance/risk that *you* get diarrhea?	*1=not at all high to 5=very high*
		Imagine that you have diarrhea, how severe would be the impact on your life?	*1=not at all severe to 5=very severe*
		If you defecate in the open, does this affect the health of other members of the community?	*1=affects not at all to 5=affects very much*
		Health Knowledge	
		In the following we talk about health issues.	
		Can you tell me what causes diarrhea? Could you please tell me for each following aspects whether it is a cause or not?	
Diarrhea Knowledge	*Causes*	Food touched by an infected person	*1=Yes, 2=No, 3=I don't know*
		Contact with the saliva of an infected person	*1=Yes, 2=No, 3=I don't know*
		Shaking hands with an infected person	*1=Yes, 2=No, 3=I don't know*
		Water contaminated by bacteria	*1=Yes, 2=No, 3=I don't know*
		Defecate in the open	*1=Yes, 2=No, 3=I don't know*
		Flies touching the food	*1=Yes, 2=No, 3=I don't know*
		Could you please tell me for each whether it is a body effect of diarrhea or not?	
Diarrhea Knowledge	*Body Effects*	Cough	*1=Yes, 2=No, 3=I don't know*
		Loss of water and salt from the body	*1=Yes, 2=No, 3=I don't know*
		Fever	*1=Yes, 2=No, 3=I don't know*
		Three or more loose stools per day	*1=Yes, 2=No, 3=I don't know*
		Now I will present you some potential preventive measures against diarrhea.	

		Could you please tell me for each whether it is a preventive measure or not?		
Diarrhea Knowledge	*Prevention*	Drinking treated water (e.g. chlorinated, filtered, boiled)		*1=Yes, 2=No, 3=I don't know*
		Using safe latrines for defecation		*1=Yes, 2=No, 3=I don't know*
		Drinking oral rehydration salt		*1=Yes, 2=No, 3=I don't know*
		Washing hands with soap after eating		*1=Yes, 2=No, 3=I don't know*
		Was someone else than the respondent and you present during the interview?		*1=Yes, 2=No, 3=I don't know*
				1=Yes, 2=No, 3=I don't know
		Who was present besides the respondent?	1	*Wife*
			2	*Spouse*
			3	*Children*
			4	*Other relatives*
			5	*Visitor*
			6	*supervisor*
			7	*mother and/or father*

This was the last question. And the interview is now finished. Thank you very much for taking the time for the interview. If you have any questions concerning the study please feel free to ask them. If you have any comments you want to make about latrine use, latrine construction or open defecation please also let us know about it right now!
With your answers you helped us to improve the activities of Global Communities and we are really grateful that you allowed us to take your time.

INTERVIEWER: The following section is for observation purposes only. DO NOT READ THIS TO THE PERSON! Please ask to take a look around and check statements according to your own judgement based on the joint definitions found in the training. If necessary, ask for the people to show you where their latrine is located.

Are there animals inside the house?			*1=Yes, 2=No*
Are there animal faeces inside the house?			*1=Yes, 2=No*
Are there human faeces inside the house?			*1=Yes, 2=No*
How is the floor inside the house?	1	*clean, well swept, free from dirt*	
	2	*quite clean, some dirt*	
	3	*not swept, dirty floor*	
Is there rubbish/ garbage inside the house?	1	*yes, lying everywhere*	
	2	*yes, organised in heaps*	
	3	*yes, some in heaps, some lying around*	
	4	*no*	
Are there flies inside the house?			*1=Yes, 2=No*
Are there animals near or in the cooking area?			*1=Yes, 2=No*

	Are there human faeces just outside the house?		*1=Yes, 2=No*
	Are there animals outside the house?		*1=Yes, 2=No*
	Are there animal faeces just outside the house?		*1=Yes, 2=No*
Latrine Observation	What type of latrine is it?	1	*Simple pit latrine (not ventilated)*
		2	*Ventilated improved pit latrine (VIP or KVIP)*
		3	*Pour flush latrine (connected to pit)*
		4	*Flush latrine (connected to pit)*
		5	*Pour flush latrine (connected to sewer)*
		6	*Flush latrine (connected to sewer)*
		7	*Bucket latrine*
	Are there seperate latrines for women and men?		*1=Yes, 2=No*
	How far is the latrine from the house?	1	*within the compound*
		2	*less than 5 minutes walk outside the compound*
		3	*more than 5 minutes walk outside the compound*
		4	*more than 10 minutes walk*
		5	*more than 15 minutes walk*
	In which state of construction is the latrine?	1	*pit is dug*
		2	*pit is decked*
		3	*pit is lined*
		4	*it has a slab*
		5	*superstructure is constructed*
		6	*it is roofed*
		7	*it has a door*
		8	*it is plastered*
	What is the floor (slab) of the latrine constructed of?	1	*Wood*
		2	*Bamboo*
		3	*cement*
		4	*Earth*
		5	*tile*
		6	*no decking so far*
	Is the slab even and easy to sweep?		*1=Yes, 2=No, 3=not applicable*
	Are there any holes in the slab? Is there somewhere another hole than the defecating hole where you can see through into the pit?		*1=Yes, 2=No, 3=not applicable*

Is there a lid for the hole?		*1=Yes, 2=No, 3=not applicable*
Does the lid completly cover the hole to prevent flies from entering the pit?		*1=Yes, 2=No, 3=not applicable*
Can the cover be handled without risk of contamination?		*1=Yes, 2=No, 3=not applicable*
Is there a pan or squat plate?		*1=Yes, 2=No, 3=not applicable*
What is the pan/ squat plate made of?	1	*Wood*
	2	*cement*
	3	*Ceramic*
	4	*tile*
	5	*soil*
	6	*Plastic*
What is the latrine superstructure constructed of?	1	*Wood*
	2	*Bamboo*
	3	*bricks*
	4	*Tin*
	5	*Plastic*
	6	*Thatch*
	7	*Cloth/Sack*
	9	*straw*
	8	*no superstructure*
Does the door shut completely dark?	1	*No*
	2	*Yes*
	3	*no door*
What is the latrine door constructed of?	1	*Wood*
	2	*Bamboo*
	3	*Plastic*
	4	*Cloth/Sack*
	6	*Metal*
	7	*Tin*
	8	*hard plastic*
What is the latrine roof constructed of?	1	*Thatch*
	2	*Metal/Zinc*
	3	*Plastic*
	8	*mud*
	5	*wood*
	6	*cement*
	7	*straw*
	4	*No roof*
Privacy of latrine: how can the latrine be closed?	1	*no door, no privacy*
	2	*no door, but privacy is respected*

	3	*door can be closed but not locked*
	4	*door can be locked*
	5	*still under construction*
Cleanliness of the latrine	1	*clean: no dirt no faeces*
	2	*somewhat clean: some dirt but no faeces*
	3	*dirty: faeces on slab*
	4	*seems unused*
	5	*still under construction*
How is the disposal of anal cleansing material managed?	1	*I cannot see how it is disposed*
	2	*it is disposed in the hole*
	3	*there is a seperate container for the material*
	4	*it is disposed on the floor*
	5	*it is disposed outside around the latrine outside*
	6	*still under construction*
Is there a possibility to wash hands close to the latrine?	1	*yes*
	2	*no*
What utensils are there for handwashing?	1	*only water*
	2	*only soap/ detergents*
	3	*water and soap*
	5	*ash and water*
	6	*Tippy Tap*
	7	*Hand sanitizer*
	9	*Veronica Bucket*
Are there flies inside or around the latrine?	1	*no flies at all*
	2	*some flies*
	3	*rather many flies*
	4	*quite a lot of flies*
	5	*many flies*
Does the latrine smell?	1	*yes, smell of faeces*
	2	*no smell of faeces*

Check the ID number on the wall of the house. Does it need to be renewed? If yes, please do so.

THANK YOU FOR CONDUCTING THIS INTERVIEW

Annex II: Supportive material for Chapter 4 and 5

Table A II. 1: *Chapter 4: Items included in analysis*

Risk factor block			
Vulnerability	Generally, how high do you think is the risk that you get diarrhoea?	1=not at all high to 5=very high	score of 14 items relating to reasons, body effects and preventive measures for diarrhoea
Severity	Imagine that you have diarrhoea, how severe would be the impact on your life?	1=not at all high to 5=very high	
Health Knowledge	Can you tell me what causes diarrhoea? Could you please tell me for each following aspects whether it is a cause or not?		
	Food touched by an infected person	1=Yes; 0=No; 99=I don't know	
	Contact with the saliva of an infected person	1=Yes; 0=No; 99=I don't know	
	Shaking hands with an infected person	1=Yes; 0=No; 99=I don't know	
	Water contaminated by bacteria	1=Yes; 0=No; 99=I don't know	
	Defecate in the open	1=Yes; 0=No; 99=I don't know	
	Flies touching the food	1=Yes; 0=No; 99=I don't know	
	Could you please tell me for each whether it is a body effect of diarrhoea or not?		
	Cough	1=Yes; 0=No; 99=I don't know	
	Loss of water and salt from the body	1=Yes; 0=No; 99=I don't know	
	Fever	1=Yes; 0=No; 99=I don't know	
	Three or more loose stools per day		
	Could you please tell me for each whether it is a preventive measure for diarrhoea or not?		
	Drinking treated water (e.g. chlorinated, filtered, boiled)	1=Yes; 0=No; 99=I don't know	
	Using safe latrines for defecation	1=Yes; 0=No; 99=I don't know	
	Drinking oral rehydration salt	1=Yes; 0=No; 99=I don't know	

	Washing hands with soap after eating	1=Yes; 0=No; 99=I don't know	
Attitudes factor block			
Affective beliefs	How proud are you of your own latrine?	1=not at all proud to 5= very proud	α (T0) = 0.29 α (T1) = 0.28
	Do you think you are more respected by your community because you have your own latrine?	1= not at all more respected to 5= very much more respected	
	If you construct a latrine, how vulnerable are you for envy?	1=not at all to 5=very much	
Instrumental beliefs	How expensive do you think is it to construct your own latrine?	1=not at all expensive to 5= very expensive	α (T0) = 0.39 α (T1) = 0.61
	How difficult is it to find the money to construct your own latrine?	1=not at all difficult to 5= very difficult	
	How difficult is it to find the time and effort to construct your own latrine?	1=not at all difficult to 5= very difficult	
Norm factor block			
Descriptive norm	How many of your relatives within your community constructed their own latrines?	1=(Almost) nobody (0%) to 5=(Almost) all of them (100%)	α (T0) = .72 α (T1) = 0.94
	How many members of your community constructed their own latrines?	1=(Almost) nobody (0%) to 5=(Almost) all of them (100%)	
Injunctive norm	How much do people who are important to you (e.g. family, parents, friends) approve that you construct a latrine?	1=approve not at all to 5=approve very much	α (T0) = 0.75 α (T1) = 0.75
	People who are leaders in the community (e.g. opinion leader, Chief of village, etc.) how much do they encourage you to construct your own latrine?	1=not at all to 5=very much	
Abilities factor block			
Action Knowledge	Can you tell us for each of the following features if this is necessary for a hygienically safe latrine?		
	paint the walls	1=Yes; 0=No; 99=I don't know	score of 6 items
	vent pipe	1=Yes; 0=No; 99=I don't know	

	have separate latrines for men and women	1=Yes; 0=No; 99=I don't know	
	decking without holes (other than the drop hole)	1=Yes; 0=No; 99=I don't know	
	weeding around the latrine	1=Yes; 0=No; 99=I don't know	
	dark inside the latrine	1=Yes; 0=No; 99=I don't know	
Self-efficacy	How confident are you that you can construct a latrine even if this is difficult (e.g. gathering the materials)?	1=not at all confident to 5=very confident	α (T0) = 0.68 α (T1) = 0.78
Maintenance self-efficacy	How confident are you that you could finish the construction of a latrine even if problems arise (e.g. you run out of money)?	1=not at all confident to 5=very confident	
Recovery self-efficacy	Imagine that the latrine was damaged. How confident are you that you will be able to repair the latrine again?	1=not at all confident to 5=very confident	
Self-regulation factor block			
Action planning	Do you have a plan when you will construct a latrine?	1=Yes; 0=No	score of 5 items
	Do you have a plan how you will gather the materials for the latrine construction?	1=Yes; 0=No	
	Do you have a plan how you will get the money to buy the materials for the latrine construction?	1=Yes; 0=No	
	Do you have a plan who will help you to construct the latrine?	1=Yes; 0=No	
Coping planning	Do you have a plan how you can construct a latrine if you are running out of materials?	1=Yes; 0=No	
Commitment	How committed are you to construct a latrine?	1=not at all committed to 5=very committed	α (T0) = 0.61 α (T1) = 0.66
Personal norm	How strongly do you feel a personal obligation to construct your own latrine?	1=not at all to 5=very much	

Note: Cronbach's alpha reported for baseline and follow-up respectively. All values were later on transformed to range between 0 and 1

Table A II 2: *Chapter 4: 4. Descriptive measures, Intra-class correlation and correlation matrix for psychosocial determinants*

	Mean	*SD*[a]	*P (ICC)*[b]	1	2	3	4	5	6	7	8	9	10	11	12
Vulnerability	-0.06	0.46	0.04	-.06**											
Severity	0.06	0.32	0.07	.04*	.24**										
Health knowledge	-0.02	0.16	0.04	-.08**	.05**	-.02									
Feelings	0.06	0.23	0.06	-.10**	.10**	.09**	.00								
Beliefs about costs/benefits	0.01	0.29	0.05	-.09**	.00	.00	-.04*	.15**							
Other's behaviour	0.42	0.44	0.65	.70**	-.09**	.03	-.09**	-.11**	-.09**						
Other's (dis)approval	0.28	0.42	0.14	.28**	.03	.10**	-.09**	.07**	.06**	.27**					
How-to-do-knowledge	0.12	0.25	0.19	.10**	.08**	.11**	-.03	.01	-.02	.10**	.02				
Self-efficacy	0.18	0.35	0.06	.19**	.15**	.03	-.07**	.13**	.01	.21**	.21**	.08**			
Commitment/pers. norm	0.08	0.28	0.10	.17**	.10**	.15**	-.06**	.11**	.07**	.17**	.23**	.09**	.35**		
Action Planning	0.33	0.44	0.34	.68**	.00	.03	-.05**	-.02	-.09**	.47**	.21**	.14**	.25**	.19**	
Barrier Planning	0.13	0.48	0.02	.05**	.06**	.06**	.05**	.08**	-.02	.04*	.02	.08**	.18**	.12**	.18**

Significance levels: *p < 0.05, **p < 0.01. Determinants are differences baseline to follow-up (grand-mean cantered).
[a] *SD*= standard deviation
[b] *P (ICC)*=Intra-class correlation

Table A II 3: *Chapter 4: Results of single multilevel mediations of intervention effect on latrine construction mediated by changes in RANAS-based psychosocial determinants*

	CLTS intervention (a-path)					Latrine construction (b-path)					Indirect effects (a*b-path)		
				CI95					CI95			CI95	
	Estimate *(SE)*	p	OR	LL	UL	Estimate *(SE)*	p	OR	LL	UL	Estimate *(SE)*	LL	UL
Vulnerability											0.12 (0.20)	-0.27	0.51
fixed intercept	0.01 (0.03)	0.643	1.01	0.96	1.07	4.09 *(0.25)*	0.000	59.80	36.20	98.79			
fixed effect	-0.02 *(0.03)*	0.546	0.98	0.92	1.05	-6.43 *(1.73)*	0.000	0.00	0.00	0.05			
random intercept	<0.01 (<0.01)	0.000				3.55 (0.69)	0.000						
random slope (level 2)						0.98 (0.56)	0.078						
residual variance (level 1)						0.20 (<0.01)	0.000						
Severity											<-0.01 *(0.21)*	-0.42	0.42
fixed intercept	<0.01 *(0.03)*	0.921	1.00	0.94	1.07	4.16 (0.46)	0.000	64.20	25.38	162.39			
fixed effect	<0.01 *(0.03)*	0.992	1.00	0.93	1.07	6.36 (2.79)	0.023	576.51	2.17	152817.55			
random intercept	<0.01 (<0.01)	0.002				3.46 (0.68)	0.000						
random effect (level 2)						1.12 (0.47)	0.000						
residual variance (level 1)						0.09 (<0.01)	0.000						
Health Knowledge											0.91 *(1.6)*	-2.23	4.05
fixed intercept	0.02 (0.04)	0.596	1.02	0.95	1.10	3.37 (4.24)	0.000	28.93	0.01	139385.67			
fixed effect	-0.03 (0.04)	0.487	0.97	0.90	1.05	-34.09 *(11.03)*	0.427	0.00	0.00	0.00			
random intercept	<0.01 (<0.01)	0.499				2.94 (1.42)	0.000						
random effect (level 2)						2.33 (8.37)	0.781						
residual variance (level 1)						0.02 (<0.01)	0.000						
Feelings											1.07 (0.58)	-0.07	2.22
fixed intercept	0.04 (0.01)	0.01	1.04	1.01	1.07	4.03 (0.30)	0.000	56.26	30.88	102.51			
fixed effect	-0.05 *(0.01)*	0.000	0.95	0.92	0.98	-21.20 *(11.91)*	0.075	0.00	0.00	13.82			
random intercept	<0.01 (<0.01)	0.000				2.95 (0.90)	0.000						
random effect (level 2)						7.46 (2.26)	0.000						

residual variance (level 1)						0.05 (<0.01)	0.000						
Beliefs about costs and benefits											0.25 (1.06)	-1.83	2.33
fixed intercept	0.03 (0.02)	0.142	1.03	0.99	1.07	4.22 (2.32)	0.069	68.24	0.66	7079.79			
fixed effect	-0.04 *(0.02)*	0.087	0.96	0.92	1.01	-6.25 (27.44)	0.820	<0.01	<0.01	18.76			
random intercept	<0.01 (<0.01)	0.000				3.41 (1.08)	0.000						
random effect (level 2)						4.36 (9.76)	0.655						
residual variance (level 1)						0.08 (<0.01)	0.000						
Others' behaviour											1.75 (0.34)	1.08	2.42
fixed intercept	-0.15 *(0.04)*	0.000	0.86	0.80	0.93	1.38 (0.91)	0.130	0.39	0.29	0.53			
fixed effect	0.28 (0.05)	0.000	1.33	1.21	1.45	6.18 (0.45)	0.000	300.07	114.66	785.25			
random intercept	0.09 (<0.01)	0.000				0.52 (0.35)	0.145						
random effect (level 2)						0.30 (0.16)	0.051						
residual variance (level 1)						0.07 (<0.01)	0.000						
Others' approval											1.72 (1.02)	-0.27	3.72
fixed intercept	-0.10 *(0.03)*	0.001	0.91	0.85	0.96	2.42 (0.95)	0.000	11.25	1.69	74.74			
fixed effect	0.15 (0.04)	0.000	1.16	1.08	1.24	11.84 *(4.76)*	0.013	138136.83	10.24	1864017608.90			
random intercept	0.02 (<0.01)	0.001				2.57 (0.86)	0.000						
random effect (level 2)						0.73 (1.63)	0.655						
residual variance (level 1)						0.16 (<0.01)	0.000						
How-to-do-knowledge											0.13 (0.11)	-0.10	0.35
fixed intercept	-0.03 *(0.03)*	0.282	0.97	0.91	1.03	3.63 (0.25)	0.000	37.64	22.65	62.55			
fixed effect	0.04 (0.03)	0.243	1.04	0.97	1.11	3.25 (1.73)	0.061	25.82	0.81	824.68			
random intercept	0.01 (<0.01)	0.000				3.54 (0.63)	0.000						
random effect (level 2)						0.41 (0.27)	0.127						
residual variance (level 1)						0.05 (<0.01)	0.000						
Confidence in performance/ maintenance/ recovery											1.75 (0.69)	0.39	3.10
fixed intercept	-0.09 *(0.02)*	0.000	0.92	0.89	0.95	3.95 (1.41)	0.000	51.99	3.08	877.43			
fixed effect	0.12 (0.02)	0.000	1.12	1.08	1.17	15.22 (4.45)	0.001	4057185.24	550.04	29926194378.75			
random intercept	0.01 (<0.01)	0.001				2.72 (0.70)	0.000						
random effect (level 2)						0.96 (6.39)	0.881						
residual variance (level 1)						0.11 (<0.01)	0.000						

Commitment											0.67 (0.43)	-0.18	1.52
fixed intercept	-0.06 *(0.03)*	0.05	0.94	0.89	1.00	4.00 (0.52)	0.000	54.38	19.30	153.24			
fixed effect	0.08 (0.04)	0.041	1.08	1.00	1.17	8.58 (3.12)	0.006	5340.10	10.52	2711465.98			
random intercept	0.01 (<0.01)	0.006				3.16 (0.67)	0.000						
random effect (level 2)						2.15 (3.27)	0.511						
residual variance (level 1)						0.07 (<0.01)	0.000						
Action Planning											6.03 (1.31)	3.47	8.59
fixed intercept	-0.32 *(0.09)*	0.000	0.73	0.61	0.87	3.93 (0.55)	0.000	50.86	16.83	153.70			
fixed effect	0.43 (0.09)	0.000	1.53	1.27	1.85	14.20 (0.34)	0.000	1468864.19	738222.09	2922646.21			
random intercept	0.03 (<0.01)	0.000				3.11 (0.77)	0.000						
random effect (level 2)						1.77 (1.33)	0.175						
residual variance (level 1)						0.13 (<0.01)	0.000						
Barrier Planning											0.10 (0.29)	-0.47	0.68
fixed intercept	-0.01 *(0.04)*	0.769	0.99	0.92	1.06	4.06 (1.33)	0.000	0.31	0.04	2.19			
fixed effect	0.01 (0.04)	0.722	1.01	0.94	1.09	7.64 (3.34)	0.022	788.40	0.00	150616092121.47			
random intercept	<0.01 (<0.01)	0.189				3.35 (0.76)	0.000						
random effect (level 2)						0.47 (0.23)	0.036						
residual variance (level 1)						0.22 (<0.01)	0.000						

Note: Level 1: individuals, level 2: communities. *SE*= standard error. *OR*= Odds Ratio. *CI*=confidence interval.

Table A II. 4: *Chapter 5: Correlation of social identity items*

		1	2	3	4	5
In-group Ties	I have a lot in common with other community members.					
	I find it difficult to form a bond with other community members.	0.06**				
Centrality	I often think about the fact that I am a member of this community.	0.19**	0.09**			
	In general, being a member of this community is an important part of my self-image.	0.24**	0.11**	0.42**		
In-group Affects	In general, I am glad to be a member of this community.	0.23**	0.07**	0.33**	0.58**	
	I do not feel good about being a member of this community.	-0.01	0.15**	0.15**	0.23**	0.31**

Significance levels: ** $p < 0.01$. Answer scale: 1= agree not at all to 5= agree very much.

Table A II. 5: *Chapter 5: Descriptive baseline measures for dropouts and respondents of the analysis*

	Dropouts	Respondents	*Cramer's V*	*p*	
n	609	2607			
Occupation			0.05	0.003	
farming	76.1%	81.3%			
other (trading, mining, fishing)	23.9%	18.7%			
Religion			0.04	0.271	
Islam	26.9%	26.1%			
Christian	53.1%	48.8%			
Traditional religion	15.4%	19.6%			
Atheists	4.5%	5.5%			
Female respondents	43.3%	42.4%	0.01	0.665	
Ability to write	30.2%	18.9%	0.11	<.001	
Open defecation	95.3%	95.6%	<0.01	0.802	
	Mean *(SD)*	Mean *(SD)*	F	*p*	*d*
Age	39.27 *(17.48)*	45.15 *(15.85)*	34.16	<.001	0.26
Income	256.53 *(511.92)*	189.68 *(341.52)*	15.20	<.001	-0.18
Household size	8.36 *(4.85)*	8.78 *(4.85)*	3.66	0.056	0.09
Social identity	4.17 *(0.84)*	4.30 *(0.75)*	7.21	0.007	0.16

Note: Effect sizes for independent means according to Cohen (1992): *d*=.2 (small), *d*=.5 (medium), *d*=.8 (large) and for Cramer's *V*: *V*=.1 (small), *V*=.3 (medium), *V*=.5 (large) (Ferguson, 2009).

Table A II. 6: *Chapter 5: Behavioural assessment of open defecation frequency and open defecation frequency*

Introduction to defecation behaviour measurement	We would like to know some things about your personal defecation habit. Please try to answer each question as precisely as you can. The following questions refer to situations, when you are in your community.
Open defecation frequency	On how many of the last 7 mornings did you defecate in the open? (e.g., field, bush, roadside, side of canal, back of house, etc.). *0= no days to 7= every day* On how many of the last 7 middays did you defecate in the open? (e.g., field, bush, roadside, side of canal, back of house, etc.). *0= no days to 7= every day* On how many of the last 7 evenings or nights did you defecate in the open? (e.g., field, bush, roadside, side of canal, back of house, etc.). *0= no days to 7= every day*
Latrine use frequency	On how many of the last 7 mornings did you use your latrine? *0= no days to 7= every day* On how many of the last 7 middays did you use your latrine? *0= no days to 7= every day* On how many of the last 7 evenings or nights did you use your latrine? *0= no days to 7= every day*

Note. Items based on the Safe San Index (Jenkins et al., 2014).

Annex III: Intervention materials

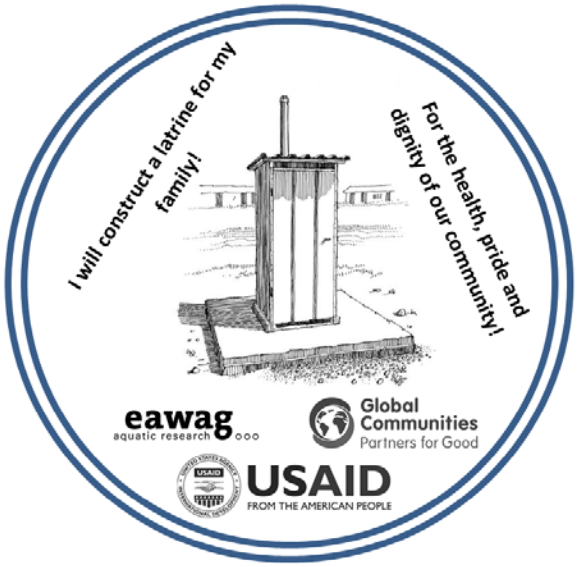


Figure A III.1: *Sticker given to households for their public commitment to construct a latrine*

Figure A III.2: *Sticker attached to a household's door →*

Figure A III.3: *Flag printed for households that have completed their latrines*

Figure A III.4: *Flag attached to a completed household latrine*

Figure A III.6: *Completed household action plan*

Annex IV: Project photos Ghana

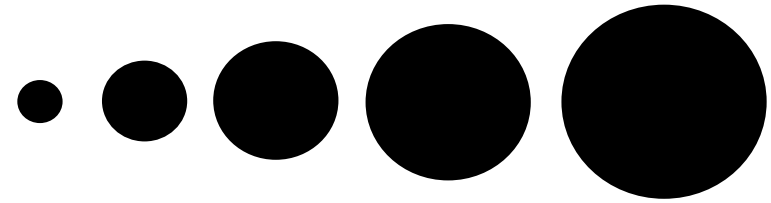


Figure A IV.1: *Visual scale used for all surveys for Likert-type answer scales*

Figure A IV.2: *Application of the visual scale in a household interview*

Figure A IV.3: *Discussion and translation of questionnaire items in language groups*

Figure A IV.4: *Newly dug pit for a household latrine*

Figure A IV.5 and 6:

Completed household latrines

Figure A IV.7: *Training for natural leaders (Global Communities)*

Figure A IV.8: *Training for CLTS facilitators (Global Communities)*

Figure A IV.9: *Data collection team long-term follow-up Ghana (2018)*